Electrical World

The consolidation of ELECTRICAL WORLD AND ENGINEER and AMERICAN ELECTRICIAN.

VOL. 59. NEW YORK, SATURDAY, JUNE 8, 1912. No. 23.

PUBLISHED WEEKLY BY

McGraw Publishing Company

JAMES H. McGRAW, Pres. C. E. WHITTLESEY, Sec'y and Treas

239 West 39th Street, New York

TELEPHONE CALL: 4700 BRYANT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

CHICAGO OFFICE.....Old Colony Building
PHILADELPHIA OFFICE.....Real Estate Trust Building
CLEVELAND OFFICE.....Schofield Building
LONDON OFFICE.....Hastings House, Norfolk St., Strand

TERMS OF SUBSCRIPTION.

Subscription price in United States, Cuba and Mexico, $3 per year. Canada, $4.50; elsewhere, $6. Foreign subscriptions may be sent to the London office.

Requests for changes of address should give the *old* as well as the new address. Date on wrapper indicates the month at the end of which subscription expires.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the New York office ten days in advance of the date of issue. New advertisements are received up to Wednesday noon of the week of issue.

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Entered at the New York Post Office as Second Class Mail Matter.

The circulation of Electrical World for 1911 *was* 965,500. *Of this issue* 17,500 *copies are printed.*

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THE INTERNATIONAL RADIO-TELEGRAPH CONGRESS.

The International Congress on Radio-telegraphy now being held in London is charged with heavy responsibilities. At the previous conference in Berlin the general plans for the regulation of radio communications were fairly well formulated, but since that time there have been improvements in the art and a vast amount of valuable experience has been gathered to serve as a guide to future action. At the present time the necessity for not only governmental but international control of radio-telegraphy is fully appreciated and the time is ripe for thoroughgoing action. Looking at the subject in a large way, the fundamental fact on which regulation should be based is that the function of overwhelming importance which must be fulfilled at all hazards is the use of wireless to secure safety on the sea. In other words, its maritime importance enormously transcends any usefulness which it has for commercial communications inland or even for sending messages over seas. As our readers will remember, the most important regulations established in the Berlin conference in 1906 were those governing the sending wave-lengths for different classes of service and compulsory interchange of maritime messages irrespective of the particular system employed. Thus the main object of securing easy communication between ships and shore with a minimum of interference and difficulty was in a measure attained, but experience has shown that much still remains to be done before the difficulties of the situation can be cleared away.

The general scheme that was promulgated in the Berlin conference was to confine coastal stations and ships' equipments to the use of wave-lengths of 300 or 600 meters, to reserve for governmental use wave-lengths a few hundred meters on each side of 1000, and to assign to overseas work and similar long-distance telegraphy wave-lengths from 1600 meters upward. There were also regulations limiting the power ordinarily to be used on ships' apparatus, the normal limit of power transmitted to the apparatus being set at 1 kw. It would seem that these regulations, wisely meant and effective within limits, reflect a state of the art which has now been outgrown. Syntonic apparatus in wireless telegraphy has been, we must admit, of relatively slow development. We have been compelled from time to time to make somewhat severe comments on the lack of, or negligence of, syntonic equipment. Time and again there has been interference of the most exasperating kind when continuity of service has been of great importance. Nevertheless, it is true that much progress has been made in syntonic work within the past few years, so that there is adequate reason for further adherence to the wave-length specified at the Berlin

conference, provided such regulations as may now be established are thoroughly enforced.

A large amount of experience, culminating in the somewhat scandalous happenings in connection with the *Titanic* disaster, must be taken into account in dealing with the problem. To begin with, the short wave-length of 600 meters assigned to ships' stations is rather a handicap in emergencies, and limitation of power, although the limit may be exceeded in case of need, has a constant tendency in connection with the short wave-length to bring about under-equipment, so that the actual radius of action of most ships' plants is considerably less than would be desirable. Provision should be enforced for large increase both of power and wave-length in case at least of distress signals or communications resulting therefrom, whatever may be the wave-length or power commonly used. Both governmental and public-service shore stations should be equipped for the reception at all times of distress signals of whatever wave-length may be determined for them. As the case now stands it is perfectly possible for a public station of the first order of importance, capable of working over the whole area of the North Atlantic, to be utterly useless in time of great emergency, whereas it should be the first station to catch messages and repeat them to the points where they will do the most good. Such a plant working at a precisely adjusted wave-length of 2000 or 3000 meters might go steadily on about its business quite ignorant of calls for help even a short distance off shore.

For purposes of safety either the station should be equipped with apparatus tuned continuously to ships' frequency or the ships should be able to send at the general shore frequency. Interchange of signals between stations equipped with different systems is now pretty general, although sometimes rather grudgingly carried out. A little closer governmental control with a heavy hand laid promptly on the offenders should secure adequate remedies for what little trouble of this kind now exists. One troublesome problem which must be encountered is due to the very fact that pretty close syntonism is now possible. For general commercial usefulness it is desirable that the stations operated within a given area should be very closely tuned so that accidental interference will be unlikely. On the other hand, if their pitches extend over too wide a range their usefulness in receiving maritime messages either of distress or business will be very much limited. A ship sending a distress call in the hope of being heard by a group of closely tuned syntonic stations would have to send untuned signals of the approximate average wave-length of the shore stations or run the chance of getting nothing through unless the shore stations were fitted for a continuous reception of a known ships' wave-length.

In our own country perhaps the most important issue is the regulation of the almost innumerable amateur stations. It is really very instructive to ride through the suburbs of almost any city with an eye out for antennas. It is not uncommon to find a dozen or so within the radius of a few miles, and they are scattered far and wide all along the seacoast and inland as well. Fortunately most of them are of small power, but on the other hand most of them are either untuned or operated without the slightest regard to the use of definite pitch, so that even a carefully tuned coast station may be quite unable to escape the chatter of small and numerous disturbers of the peace. Rigorous licensing, limitation of the power of the sending apparatus, and enforced tuning to a wave-length far shorter than anything in general use, would minimize the effect of this really very serious cause of disturbance without materially interfering with the amusement of the amateurs, who could listen if they pleased to anything within the scope of their apparatus, but would be compelled to send only the pitch that would not cause serious interference. Another group of plants which must not be left out of account in studying the situation are the stations devoted, in the words of the Berlin conference, to the "correspondence of private interests"; that is, private stations established strictly for business purposes. It is not easy to tell how best to deal with this particular class of stations. Perhaps the simplest process for the present would be to leave them entirely out of account as possible auxiliaries in maritime service and to require them to work with accurate tuning within a particular range of wave-lengths assigned to this service, a range perhaps intermediate between that assigned to ships' service and that in use in government stations. At all events, it is plain to see that the London conference has its work laid out for it, and it is earnestly to be hoped that whatever conventions are entered into by the representatives of this government will be promptly and fully ratified so that the whole art can be put under effective international regulation without any further delays.

THE ADJUSTABLE-SPEED DIRECT-CURRENT MOTORS.

We print this week an instalment of a very clearly written and illustrated article, by Prof. A. D. Du Bois, on a subject of great practical importance which is not generally treated by electrical engineering textbooks in so condensed yet comprehensive a form. The facts are known to engineers, but they lie scattered in various papers or in different sections of a textbook. The function of all industrial motors is to drive machinery of some kind. From a dynamic standpoint the machinery requires a certain driving torque to be exerted on it at a certain speed or angular velocity. The product of these two variables is the power that has to be delivered by the motor mechanically. From this point of view, all rotating machines differ only in their torque and speed characteristics. Some machines, such as certain cotton-spinning machines, require the maintenance of a constant speed at more or less constant torque. Other machines, such as certain printing presses, require closely adjustable speeds at nearly constant torque. Yet other machines, such as certain hoists, require closely adjustable speeds at closely adjustable torque. As the article points out, the speed-torque curve, or set of curves, for any given machine, representing the range of speeds that it demands and the corresponding range of its torque, is of great importance to the electrical engineer who undertakes to operate it by a driving motor.

The easiest condition for the ordinary direct-current shunt motor to meet is that of variable torque at nearly

constant speed. This condition is fortunately met with in a large number of machines constituting the constant-speed class. There is, however, another and a constantly growing class of machines which demands adjustable-speed operation, and this always calls for a more expensive motor. As the article points out, there are three fundamental methods of controlling the speed of a direct-current motor; namely, by changing the flux, the armature volts, or the number of active armature conductors in circuit. Which one, or which pair, of the three fundamental methods is preferable in any given case depends upon various conditions, and especially upon the speed-torque characteristics of the load. None of the methods is perfectly satisfactory, and each has certain advantages of its own. The direct-current motor is distinctly superior to the alternating-current motor in provisions for adjustable-speed operation; but even the direct-current motor is far from meeting the requirements in an ideal way.

It is a remarkable fact, as indicated, that by no one of the three fundamental methods of speed control taken alone is it possible to make the torque of a motor increase as its speed increases, notwithstanding the fact that in a number of cases presented in industrial practice the torque of a load increases with the speed, as, for example, in fan blowers. Another interesting conclusion drawn from the analysis is that the inherent speed regulation is worse on low speeds with the voltage-control method than with the flux-control method. This of course is an incident to the increased I^2R loss of power in conductors at low voltages, and is not an inherent defect in the voltage-control method considered alone. For the same reason, low-voltage generators—that is, generators of under 50 volts emf—are likely to show relatively low efficiencies, and inherent pressure regulations, owing to the I^2R losses in brush and brush-contact resistance.

THE ELECTRIFICATION OF A LIGHT RAILWAY.

We describe elsewhere an Austrian combined railway and lighting plant which is sufficiently out of the ordinary to involve some rather valuable lessons in electrification. The plant in question operates a branch of the Austrian State Railway which runs for 51 miles through the wild Styrian mountains. Started as a steam road, this line has just been skilfully converted to electrical operation. Its most notable feature, from an American standpoint, is that it is a light, narrow-gage road, a type practically unknown in this country, although capable of great usefulness in situations where standard-gage lines are costly and difficult to construct. The actual gage in this case is only 30 in. and the rails weigh only 44 lb. to the yard. Such a light railway is admirably adapted for its purpose and can unquestionably be built and operated at considerably lower cost than the standard-gage roads generally employed. There seems to be an inherent theory in the mind of the American engineer that all electrical lines—however inconsequential—are liable to become parts of trunk-line systems, even when the roads run only between mountain villages with very modest traffic. Could we be freed of this obsession, many more profitable branch railways would be built to serve as feeders for the heavier lines, the capillaries, so to speak, in industrial circulation.

Built as it was for a steam road, the grades are light from an American standpoint, none being greater than 2.5 per cent. It is interesting to note that the cause for the change of motive power was an increase of traffic so great that operation by steam became burdensome. Two power plants have already been developed to handle the electrical load of the system, both of which are illustrated in our article. These plants are not unusual in design or construction, except in so far as they involve combined three-phase and single-phase operation. In electrifying the road it was found desirable to furnish light and motor service to the country tributary to the line. Use is, therefore, made of three-phase plants feeding energy to the general system in the usual way and delivering energy over only one phase for the railway service. The use of single-phase motor in preference to the three-phase, which would have been readily built, is strong evidence of the successful evolution of single-phase traction in meeting even rather severe requirements of railway traffic. The combined functions of the plant made it desirable to depart somewhat from the very low frequency used on the foreign single-phase lines, and all of the electrical equipment, both the two hydraulic plants and the Diesel engine auxiliary, is worked at 25 cycles. There was apparently no hesitation in building motors for this frequency.

There is nothing remarkable about the distribution of energy. A part of it is handled from one of the stations by 65,000-volt feeders. The remainder of the system is fed from substations receiving energy from high-tension feeders at 27,000 volts. The smaller of the two hydraulic plants is used practically entirely for the three-phase distribution, the railway work calling chiefly upon the other. The stand-by station is equipped with two oil engines, each driving a 700-kva. three-phase generator. It serves the double purpose of tiding over periods of low water and of acting as an emergency relay in cases of accident. The track conductor system of the railway presents no striking peculiarities. It is of the ordinary double-catenary type, long familiar in European practice, the working conductor being placed in general 18 ft. above the rail, although the height is reduced to as low as 12 ft. at the terminals. The train equipment impresses one as somewhat heavy for the track, but in this connection it must not be forgotten that the speed is not intended to be high, only some 25 miles an hour. The locomotives are of the double-truck type, weighing 47 tons, and each truck carries an 1800-hp alternating-current series motor geared to the wheels. The double-truck construction, with its great structural flexibility, is interesting on account of the character of the roadbed, which, although without severe grades, is made up of a large number of moderate grades and presents for more than half its length curves with radii between 250 ft. and 300 ft. Altogether, the system represents a most beautiful demonstration of the practical working qualities of the light railway and of the adaptability of single-phase traction to meet the severe requirements of mountain service.

LONDON RADIO-TELEGRAPH CONGRESS.

At the opening meeting of the Second International Radio-Telegraphic Convention, in the London quarters of the Institution of Electrical Engineers, on June 4, there were present 160 delegates from thirty countries, who were welcomed on behalf of the King and the government by Hon. Herbert Samuel, Postmaster-General. On June 10 the delegates will be received by the King at Buckingham Palace. Sir Henry Babington Smith was elected chairman of the convention in accordance with the suggestion of the Postmaster-General. The American delegation will insist on the adoption of rules providing for a twenty-four-hour radio-telegraph staff on each seagoing vessel carrying more than 100 persons and providing for precedence over all commercial and private messages of distress messages, weather observations and storm warnings. It is possible that the conference will be in session during the remainder of June. The advance proposals which will be considered by the delegates to the conference have been printed and are now obtainable from the Government Printing Office at Washington. These proposals make a pamphlet of 114 pages, which will be of particular interest to all who are engaged in or connected with the wireless industry.

N. E. L. A. CONVENTION PREPARATIONS.

(*By Telegraph.*)

Final arrangements have been made for the convention of the National Electric Light Association at Seattle. Secretary T. C. Martin and his staff arrived Saturday, June 1, and opened headquarters in the Washington Apartments, immediately adjoining the New Washington Hotel. Mr. Walter Neumuller, of the exhibition committee, opened his office in the Washington Annex. Workers are busily engaged decorating the drill hall of the National Guard Armory for exhibition purposes, and one end of the room is being partitioned off by a regulation fire wall extending from the floor to the roof. The walls of the partition are being separated by a 3-ft. air space to deaden the sound. In this newly constructed room the general sessions of the convention will be held. At either end of the hall paralleling the drill hall and not far from the entrance are two large rooms which will be utilized for sessions also. These rooms will be known as Meeting Rooms No. 2 and No. 3, the latter being to the right of the entrance and the former to the left. To the left of the main entrance as one enters is the officers' library. This will be utilized during the convention for the registration of delegates and guests, who will be provided with advance copies of papers in the room just across the hall, now the headquarters of the Second Infantry. The office of the *Convention Daily* will be to the right of the entrance on the main floor, quarters having been provided for the staff in a large hall room to the rear of Meeting Room No 3. A booth in the exhibition hall will be provided for the secretary of the association, and the Puget Sound Traction, Light & Power Company has also taken a booth in the exhibition hall, where persons conversant with the city and its sights, as well as with the Pacific Northwest in general, will be stationed. It is expected that the decorator, Mr. M. A. Singer, of New York, will complete the decorations and the erection of partitions and booths by Saturday, after which time the exhibitors will have an opportunity to arrange their respective displays. All but a few of the booths have been contracted for, and it seems certain that none will be vacant on the opening night.

The local entertainment committee, of which Mr. H. T. Edgar, of the Puget Sound Traction, Light & Power Company, is chairman, has arranged its program and submitted it to the association. Admission to all special events will be by badge of the association, and in addition to representation at the booth of the Puget Sound Traction, Light & Power Company the committee will have at least one representative of the sub-committee on hotels stationed at each of the hotels at which delegates are registered. A ladies' committee will have headquarters in the balcony of the New Washington Hotel. The Washington State Art Association has extended the courtesies of its museum galleries to delegates, and the local generating stations and substations will also be open to visitors with badges. During the convention those desiring to play golf have been invited to the links of the Seattle Golf and Country Club, the Town and Country Club of Seattle, the Tacoma Country Club and the Victoria Golf Club.

On Monday afternoon there will be a game of baseball between the nines comprising delegates from east of the Rockies and those from the Slope at the athletic field on the campus of the University of Washington, on the site of the Alaska-Yukon Exposition. Special cars will take delegates and guests to and from the field. These trips are so arranged as to show the sights of the city, the route to the ball grounds being along the shore of Lake Union and the return being made by way of the Capitol Hill residential district.

The exhibition in the armory will open on Monday night and will be followed by a reception to President and Mrs. Gilchrist in the convention hall. A promenade concert and dance will mark the conclusion of the evening's entertainment.

Automobile trips around Seattle have been arranged for Tuesday afternoon, which will require from two to two and a half hours. On Wednesday afternoon there will be a short boat trip on Puget Sound, which will afford the ladies an opportunity of viewing from the Sound the city and its wonderful panoramic setting of snow-capped mountains. Later on in the afternoon when the boat returns a musicale and tea will be given in the roof garden of the New Washington Hotel.

The ladies will visit the Seattle Golf and Country Club on Thursday. A silver loving cup has been given as a prize for a ladies' putting contest. During the afternoon the ladies will be the guests of the Westinghouse Electric & Manufacturing Company.

On Thursday night the convention hall will be given over to the Sons of Jove. On that evening the Tacoma and Seattle Jovians will do their utmost to have one of the finest rejuvenations ever held on the Pacific Coast. Reinforced by other Jovians from various parts of the country, a gala night is expected.

On Friday the delegates and guests are invited by the Puget Sound Traction, Light & Power Company for a day's trip to the Snoqualmie Falls and White River power developments. A large platform has been erected at Snoqualmie Falls from which visitors may view the plunging waters. A special train will leave the Northern Pacific station early in the morning for Snoqualmie Falls and after a stop of an hour or so at that place of scenic interest will proceed to the White River station at Dieringer, luncheon being served en route. The train will return to Seattle about 5 o'clock.

The final convention program will not depart to any extent from the program as printed in these columns on May 4. Fifty advance papers have arrived from New York and are being placed in envelopes for rapid distribution. The badges will differ somewhat from those used in previous years. Forming the background of the two styles of badges will be a representation of Mount Rainier and the waterfront of Seattle, the symbol of the association being in the center. The city lighting department will display an electric "Potlatch" sign during the convention, and the electricians of the New Washington Hotel have devised a number of electrical effects to be placed in the halls and dining-room of the hotel. Other than these no special electric decorative effects will be employed.

SPECIAL TRAIN TO SEATTLE CONVENTION.

The delegates to the N. E. L. A. convention at Seattle who embarked from New York on the "Pink Special," leaving at 8:50 a. m. on June 3 over the Pennsylvania Railroad, were treated to several pleasant surprises during the first day of their 3000-mile journey. Not the least of the enjoyable diversions provided by the forethought and energy of those in charge of the train was a player-piano in the observation car, which proved very popular. Numerous souvenirs of the trip were distributed early during the first day. Upon leaving Philadelphia, copies of a booklet were given out containing the names of those in the party and the locations of their reservations, presented with the compliments of the Wagner Electric Manufacturing Company, of St. Louis. The train itself was made up of nine steel cars, including observation, club and dining cars, with every convenience.

Later two very attractive souvenirs describing a number of Stone & Webster hydroelectric developments in Washington, including the White River plant, were presented to all in the party. Another souvenir got up in a most attractive form was a diary of the journey, with notes on the points of interest to be seen, distributed with the compliments of the General Electric Company.

At East Pittsburgh a brief stop was made to take on board the Westinghouse band, of twenty-five pieces, which rendered a number of popular airs during the run to Pittsburgh, and there serenaded the train upon its departure. At the same time several flower girls distributed bouquets of carnations to the ladies and boutonnières to the gentlemen, with the compliments of the Westinghouse Electric & Manufacturing Company. A bulletin was later posted in the observation car showing the locations of the five other special trains en route to Seattle.

A handsome album, 10.5 in. by 13.5 in., containing full-page views of various scenes en route was presented to each member of the party with the compliments of the Westinghouse Electric & Manufacturing Company. Song-books were also distributed by this company, and, with the player-piano in the observation car, it is safe to assume that the evenings will be enlivened by song.

Two of the past-presidents of the association, Mr. W. C. L. Eglin and Mr. Dudley Farrand, were among the eighty-one persons on board. The very complete arrangements for the comfort of the party were due to the energetic work of Mr. J. C. McQuiston, of East Pittsburgh, and Mr. F. McD. Quinn, representing the Pennsylvania Railroad Company.

ELECTROLYSIS FROM RAILWAY CIRCUITS.

Continuing the lively discussion which has been going on in Chicago in relation to the pending ordinance to prevent electrolytic damage, another hearing was held before the committee on gas, oil and electric light of the City Council on May 29. Mr. Ray Palmer, the city electrician, had most of the time of the long session to set forth his rebuttal of the companies' engineers' estimates of the expense of making the necessary changes called for by the proposed ordinance. The fact was brought out that there is not now a very wide discrepancy between the companies' engineers' estimates and the city electrician's estimates of the cost of carrying out the provisions of the ordinance, so far as the elevated railways are concerned. The figures vary from $1,600,000 to $2,000,000. In relation to the surface railways, however, there is a much wider variation, the estimates here being, in round figures, $5,000,000 by the city electrician and $10,000,000 by the companies' engineers. The subject is complicated, however, by the various methods of meeting the situation which seem to be permissible under the proposed ordinance, so that without further and more detailed analysis the figures do not mean much to the reader.

One fact brought out was that whereas there are fifteen substations now in use in Chicago for the surface railway systems, the companies' engineers estimate that thirty-eight would be required to comply with the proposed ordinance.

The city electrician favors, among other things, the use of negative boosters in return circuits. He was asked if negative boosters are used in this country and he answered in the negative. In explaining this fact, Mr. Palmer said that the absence of negative boosters arises from the fact that water-pipe extension departments in American cities have not employed electrical engineers to advise them in this matter. Moreover, there is no standard legalized maximum drop required throughout the United States as is the case in England. These facts account, according to Mr. Palmer, for the fact that negative boosters are not used in this country. The speaker added that Great Britain and European countries are far ahead of the United States in precautions taken to prevent electrolysis by current escaping from street-railway returns.

Mr. W. W. Gurley, counsel for the Chicago Railways Company, asked if there is any city in the United States where the law requires as low a maximum drop as 12 volts. Mr. Palmer said that there is not, but that that is no reason why the situation in Chicago should not be remedied. An animated colloquy ensued as to what might be considered prohibitive cost in adopting the remedy advocated by the city electrician.

Mr. Leon Hornstein, of the corporation counsel's office, supported Mr. Palmer, and, as the lawyer who had drawn up the proposed ordinance, gave his interpretation of it. This ordinance does not compel the use of a drainage system in addition to the return-current drop provision. The speaker and Mr. Gurley had a lively interchange over the construction of the ordinance. Mr. Palmer assisted the city's lawyer in the difficult task of endeavoring to make clear the various technical and legal variations of a complicated subject. Mr. Hornstein quoted from one of the many findings in the celebrated Peoria electrolysis case, and that was the signal for the lawyers on the side of the companies to give their interpretation of what the judge meant to say in the recent pronouncements on this case.

Mr. H. L. Lucas, the representative of the city engineer's office in charge of water-pipe extension, said that the cases of electrolysis damage to water mains in Chicago are becoming more frequent.

Mr. Leonard A. Busby, president of the Chicago City Railway Company, quoted from the so-called "final decree" in the Peoria electrolysis case to show that the court in that long-drawn-out litigation had sanctioned the trying out of a drainage system. "Why not do the same here?" inquired Mr. Busby. If the ordinance is passed it simply means litigation, and the speaker suggested that the investigation be continued by the joint efforts of the city and the companies, and that in the meantime the companies be permitted to try out the drainage system.

A rather warm discussion on the merits of the so-called "drainage system," which is another name for the pipe-bonding system, ensued. In answer to a question Mr. Palmer said that he had formerly approved of the drainage system but that he did not now. Mr. H. B. Fleming, of the Chicago City Railway Company, read a report presented last year from which the speaker drew the conclusion that at that time the present city electrician sanctioned the drainage system. Mr. Palmer said his position was misconstrued. He added that a maximum 7-volt drop would be better than the maximum 12-drop volt proposed in the ordinance, the latter being supplemented by a drainage system. He proposed the 12-volt drop and wording the ordinance in such a way that the drainage system could be used also to give the companies a little more leeway.

Costs of operation and methods of figuring cost entered into the discussion. Mr. G. T. Seely, of the elevated rail-

roads, pointed out the increased cost of operation by the use of the negative booster system.

Mr. R. H. Rice, engineer for the Board of Supervising Engineers, took part in the discussion. The board, he said, was standing neither with the city nor with the companies; every bit of information that it possesses is available for both sides. The estimates of the cost presented on both sides are based on fundamental figures of the Board of Supervising Engineers. These fundamental figures have been used and applied differently by the two sides to the controversy. Certain allowances have been made by the railway companies which Mr. Palmer thinks should not have been made. However, Mr. Rice expressed his personal belief that in the main the figures of the railway companies are correct. He doubted if the surface companies could take measures to comply with the proposed ordinance at an expense as low as $5,000,000. When the committee adjourned no definite conclusion had been reached.

RAILROAD ELECTRIFICATION.

In the series of addresses in connection with the study of Chicago's transportation problem by the City Club of Chicago, Dr. W. F. M. Goss, director of the engineering department of the University of Illinois, spoke before the club on June 3, his paper being entitled "The Electrification of Chicago Railroad Terminals." Dr. Goss spoke in a careful and conservative manner, pointing out the magnitude of the proposed electrification, its advantages and disadvantages, and the difficulty of carrying it out. He said that there are 2600 miles of railroad track in the 194 square miles of Chicago's area. There are 105 separate railroad yards in the city. While it is true that these railroad tracks cover the city like a web, nevertheless they are where they are because the people have had need of the service rendered.

Perhaps the railroads' contribution to the smoke nuisance of the city from the stacks of their 1673 locomotives is not large in comparison with the whole amount of smoke in the atmosphere of the city. The speaker gave some account of the careful and thorough manner in which the Chicago Association of Commerce committee of investigation on smoke abatement and electrification of railway terminals is studying the question. Dr. Goss is a member of this committee. He said that the companies contend that electrification is not essential to the smokeless operation of locomotives drawing trains. Hand firing is much better now than in former years, and there is also the possibility that the use of mechanical stokers on locomotives may practically eliminate smoke. Further, storage-battery locomotives or the motor-car type of locomotives using oil engines have been suggested. At this point Dr. Goss spoke briefly of the remarkable extension in the use of the Diesel oil engine. The expense entailed by the use of locomotives of this type would be small compared with the cost of general electrification. The railroads may prefer to use one of these expedients.

Two aspects of electrification present themselves. One is as applied to suburban passenger service and the other as applied to other traffic, including switching, through passenger and through freight trains. The first proposition is the simpler one. The speaker enumerated the advantages of electrification in suburban passenger service and the probable ultimate gain in business by the more attractive service. He told what would be necessary for electrification. Probably the improvement is delayed not so much because the first cost is prohibitive, but because the directors of the companies see no prospect of immediate increase in revenues as the result of the change. The proposal may be compared with that of track elevation in cities. The electrification of the suburban passenger service, while hedged about with difficulties, will no doubt lead to improvement in service, as has been the case with the elevated tracks. Gradually it will be brought about.

The complete electrification of the present steam railroad lines within the limits of the city of Chicago constitutes a problem of much greater magnitude. Probably no one knows the first cost of such an improvement or what its effect would be on operating conditions. An electric locomotive costs about twice as much as a steam locomotive of equal rating. As a guess Dr. Goss said that, in addition to the cost of the locomotive itself, it might be said that behind each locomotive there would be an additional investment hardly less than $100,000 and which might run to double that amount. The actual movement of terminal trains can probably not be accomplished more cheaply by electricity than by steam. Electrical operation has advantages, but in the case of the proposed general electrification of all the tracks in the whole city these advantages, with one exception, may be considered as minor advantages. This exception is the abolition of smoke, cinders, dirt and noise. In concluding Dr. Goss asserted that to carry out a compulsory plan of general electrification immediately would embarrass many railroad companies financially. The city will do well, he thinks, to study the problem conjointly with the railroads.

ILLUMINATION FOR KNIGHTS TEMPLARS IN PITTSBURGH.

During the conclave of the Pennsylvania Knights Templars in Pittsburgh on May 27, 28 and 29 the Allegheny County Light Company, a subsidiary of the Philadelphia Company, made a special feature of electrical decorating,

Decoration of Office Building in Pittsburgh During the Conclave of the Pennsylvania Knights Templars.

its display easily being one of the most notable in the city in honor of the Knights. The central figure of the company's display, which took up the entire front of the seven-story office building in Sixth Avenue, was a huge Maltese cross, containing the cross and crown of the order in the

center. Behind the cross and crown, which were in colored lamps, was a great white sunburst. The sunburst began lighting from the center and gradually crept out toward the ends, the effect being a most pleasing one. About 400 16-cp lamps were used in the central decoration and about 1600 lamps on the front of the building. The officials of this company estimate that in the entire city during the conclave 250,000 lamps were used in honor of the Knights, in addition to the regular lighting, with which the city is richly blessed.

ELECTRIC SYSTEM OPERATION.

At the May meeting of the Washington Section of the American Institute of Electrical Engineers Mr. Charles W. Stone presented a paper entitled "Some Problems of Substation and Central Station Operation." An abstract of this paper follows:

The exciter end of the central station seems to have almost as many designs as there are designers. The rest of the station is quite satisfactorily standardized. Not all exciter systems are economical nor can all be right. Any trouble there affects the operation of the entire system. The directly connected exciter according to the self-contained unit idea is of questionable standpoint. It is not economical to operate an exciter on high-speed machines, high-speed apparatus being very sensitive to external influences. For example, a 25-kw exciter on a 5000-kw turbine is difficult to keep in alignment. It is well to allow nothing which is likely to involve trouble on the main installation. With separate exciters the loss of an exciter causes comparatively little trouble. The motor-driven exciter, being fed with energy from the system, tends to amplify any variations. To ward off complete loss of excitation a steam-driven unit should at all times operate in parallel with the other exciters. Turbo-exciters exhausting steam into the feed-water heating system serve very admirably.

The cheapest system for voltage control on the generator is one involving a Tirrill regulator. This regulator can handle a few exciters but not many. Two regulators do not work well in parallel. The more recent method of control by paralleling the exciters on an exciting busbar and regulating by a series booster is very satisfactory. This machine is comparatively small and easily follows the regulator. In this system the additional safeguard of a storage battery can be easily provided. The battery should be parallel with the exciters, being arranged to "float" on the line. In this case it is immaterial whether the exciter busbar receives energy from the battery or the machine.

In a large number of central stations overload circuit-breakers are used on the exciters. Overload breakers in this connection are of questionable service, since a short-circuit means a shutdown, and hence the alternating-current breakers can take care of that. With motor-driven exciters it is well to use an alternating-current breaker set at four times normal load and protect the direct-current side by inverse power relay.

The difference between the American and European practice regarding the substation feeders is that according to the latter but not the former the substations are interconnected. The American system of radial distribution requires more copper but gives satisfaction.

The use of sectionalizing busbars is not always economical, as it often makes necessary the operation of more machines than the load demands from the efficiency standpoint. The insertion of load-limiting reactors is now standard practice. A reactor consists of simply a concrete core wound with bare copper. They are fireproof, well insulated and proof against sparking over. Twelve times normal current is the standard allowance. Sectionalization of busbars and the insertion of reactance limit the short-circuit current to the rating of the machines in the section in trouble and one machine in each adjoining section.

Feeders should be so arranged that the load can be taken off the system in increments rather than all at once. This plan will allow a shutdown of part of the system without interfering with the rest in the case of an emergency.

The paper was discussed by Messrs. Hanna, Smith and Bliss.

SOME RECENT ENGLISH PATENT CASES.

BY AN ENGLISH BARRISTER.

It is a curious feature of English patent litigation that much of it is inspired from the United States. One hears those who practise in courts where patent cases are tried aver that the best and most lucrative suits are those which are promoted or defended by American citizens, and, to judge from the reports, this is a true statement.

But, apart from the direct advantages it confers upon the lawyers, Anglo-American patent litigation has led to the settlement of a large number of questions of great importance and complexity in relation to recent patents. In view of the fact that the validity of some of these patents is of concern to both English and American patentees, it is probable that a review of some of the more recent of them would be of value on both sides of the Atlantic. The few representative cases cited below are not confined entirely to those that are strictly electrical.

In a recent case (Trautner vs. Patmore, 29 R. P. C., 60) it was established that unless a patent has been granted an interim injunction to restrain the use of an invention improperly obtained from the plaintiff will not be granted. In the case cited a patent was granted to the plaintiff for improvements in connection with hanging book carriers or brackets for securing books, cards, tablets and the like purposes on July 25, 1910. On July 23 the defendant was employed by the plaintiff to obtain orders for advertisements in connection with covers for telephone directories, and for this purpose the invention and a draft provisional specification were communicated to him (as the petitioner alleges) in confidence. Subsequently the defendant left the plaintiff's employ and made and sold the invention on behalf of a company of which he was a director. The plaintiff then commenced an action for infringement against the defendant and the company, and moved for an interim injunction. The defendants alleged that the patent was invalid by reason of prior publication by the defendant before July 25, 1910, prior to which, at the plaintiff's request, he had shown and explained the invention to various people on whom he had called for the purpose of obtaining orders for advertisements. There was a conflict of testimony as to what took place at the interview when the invention was communicated to the defendant. It was held that the patent, not having been established, an interim injunction could not be granted.

For the benefit of American readers it may be explained that an interim injunction is one which is granted in order to protect property, etc., pending the trial of questions as to the perpetual injunction. Cases are now comparatively frequent in relation to what is known as compulsory work. As is well known, if an English patent is not worked in the United Kingdom it runs grave risk of being revoked, and the patentee must give satisfactory reasons for not working it.

In Taylor's patent (29 R. P. C., 29) an application was made for the revocation of a patent for improvements in and relating to mechanical underfeed stokers, on the ground that the patented article was manufactured exclusively or mainly outside the United Kingdom. It was admitted that

with the exception of some parts of one machine there had been no manufacture of any kind in the United Kingdom. It was contended on behalf of the patentees that they were prevented from manufacturing in the United Kingdom in consequence of threats of an infringement action, and that as advertisements which were inserted in various journals and circulars sent to various manufacturers did not result in any business there was no demand for the patented article in the United Kingdom. It was held by the Comptroller-General of Patents that the reasons given for the manufacture of the patented article in the United Kingdom were not satisfactory, and that the efforts made by the patentees to introduce the patented article into the United Kingdom were insufficient. He therefore ordered the patent to be revoked forthwith.

In Marconi vs. British Radio Telegraph & Telephone Company, Ltd. (29 R. P. C., 217), Mr. Justice Parker, who is one of the soundest of English judges in matters relating to patents, said: "When the patent is for a combination of parts or a process, and the combination or process, besides being itself new, produces new and useful results, everyone who produces the same results by using the essential parts of the combination or process is an infringer, even though he has in fact altered the combination or process by omitting some unessential part or step and substituting another part or step which is in fact the equivalent to the part or step he has omitted." The facts of this case were of considerable interest. In 1900 a patent was granted for "improvements in apparatus for wireless telegraphy." One of the claims was for a transmitter for electric-wave telegraphy consisting of a spark producer having its terminals connected through a condenser with one circuit of a transformer, the other circuit being connected to a conductor and to earth or to a capacity, the time-period of electrical oscillations in the two circuits being the same or harmonics of each other. The invention had greatly increased the distance to which messages could be sent. In an action for infringement of the patent the plaintiffs alleged infringement by the sale of a transmitter the circuits of which were linked together by an auto-transformer instead of by a two-coil transformer, as described and shown in the specification and drawings. The defendants alleged anticipation, want of subject-matter and prior grant. They contended that the auto-transformer used by them did not come within the claims of the specification. It was held that the invention consisted in the substitution for a single circuit in both transmitter and receiver of a pair of circuits, one radiating or absorbing readily and the other oscillating persistently and being a conserver of energy, the two circuits being tuned together and linked by means of a transformer so that electrical oscillations in the closed and persistently oscillating circuit built up and maintained similar oscillations in the open and readily vibrating secondary, the two circuits of the receiver, with similar interaction, being tuned to the same time-periods as the circuits of the transmitter; that the invention was useful and the patent valid, and that the claim was for a new combination producing a new result, the two-coil transformer not being an essential part of the invention, and that the defendants, notwithstanding the fact that they had used an auto-transformer, had infringed. Judgment was given for the plaintiff with costs, except in so far as increased by the two later patents, as to which the action was ordered to stand over.

In the case of the British Westinghouse Electric & Manufacturing Company, Ltd., vs. the Electrical Company, Ltd. (29 R. P. C., 49), it appeared that a patent had been granted in 1902 for improvements in flame-arc lamps. The claim was for an arc lamp having downwardly pointing electrodes and provided with both downward and horizontal feed mechanism, so arranged that a certain amount of operation of the horizontal feed mechanism takes place before the downward feed mechanism is permitted to operate, subject to a disclaiming note. The disclaiming note was as follows: "The lamps to which this my invention applies are not of the type in which the current is supplied to the electrodes through electric holders in which the upper ends of the electrodes are firmly clipped and which are capable of being lowered simultaneously through the same distance, and about one of which the corresponding electrode can swing under the action of a device acting near its lower end, and I limit my claim to lamps of this description." In an action for infringement it was alleged that there was no evidence of utility, that the patented invention was not novel, and that the substance of the patent was to be found in certain well-known arc lamps, matters of common knowledge being added. It was held that the invention was a lamp of a certain definite type and was a distinct advance upon everything that had gone before; that it enabled flame-arc lamps to come into general and commercial use; that it gave to a definite type of lamp a floating horizontal feed in a definite manner and superior to everything which had gone before, and that it was new and useful and good subject-matter for a valid patent. It was also held that the defendants had in substance taken the patentee's lamp, although with variations; that pivoting the guides and holders was mechanically equivalent to pivoting the whole frame, that there was infringement and that the plaintiffs were entitled to judgment.

PUBLIC SERVICE COMMISSION NEWS.

NEW YORK COMMISSION.

The Public Service Commission for the First District has laid out the rapid-transit route for the extension of the new Seventh Avenue subway, to be operated by the Interborough Rapid Transit Company, to Brooklyn. The new route will leave the proposed Seventh Avenue subway in West Broadway at Murray Street and will continue through William Street and under the East River to a junction with the existing subway at or near the Brooklyn Borough Hall. The only route for the dual system now remaining to be laid out is the proposed tunnel line to Staten Island, which will be connected with the Fourth Avenue subway in Brooklyn and operated as a part of the Brooklyn Rapid Transit system.

The First District commission has received the annual report of the Kings County Lighting Company for the year ended Dec. 31, 1911. It is specially interesting for the reason that the commission, after a thorough investigation made last year, ordered the company to reduce its price for gas from $1 per 1000 cu. ft. to 85 cents per 1000 cu. ft. The order was to have taken effect Nov. 1, 1911, but the company is contesting it in the courts, and pending the decision continues to charge the old rates. The report shows that, after paying all expenses and declaring a dividend of 6 per cent on $2,000,000 capital stock, the company had left a surplus of $23,031.46. Had it sold gas at 85 cents for the last two months of the year it would still have shown a surplus. It is doubtful whether such a favorable showing would have been made had the 85-cent rate covered the entire year, but the commission in making the order held that the company is overcapitalized. Its total capitalization is something more than $5,000,000, and the commission found that it was entitled to a return upon only about $2,500,000. The theory of the commission is that upon such a capitalization its operations would show a satisfactory profit, even at 85 cents per 1000 cu. ft.

MARYLAND COMMISSION.

Governor Goldsborough has authorized the Maryland Public Service Commission to employ the New York firm of Marwick, Mitchell, Peat & Company, expert accountants, to go over the books of the Consolidated Gas, Electric Light

& Power Company. The object of this audit, which will be begun immediately, will be to check up the books to decide whether or not the inventory of the affairs of the company supplied the commission is correct. The work will take up about three weeks. After a number of weeks of hard work the commission is almost ready to begin the hearing of the electric case. The case will be ready for trial by the close of the present month.

Current News and Notes

MOTOR-DRIVEN MINT.—Following a recent midweek luncheon of the Colorado Electric Club an inspection trip was made to the Denver mint, operated throughout by individual electric motor equipment. Use is made of about 300 hp in motors.

* * *

EXPERIMENTAL WIRELESS STATION.—A tract of land about a mile long by one-quarter of a mile wide at Port Monmouth, N. J., on the Raritan Bay, has been purchased by the Marconi Wireless Telegraph Company of America, which will use this site for a testing station. Experiments will probably be made in transatlantic service.

* * *

DENVER MEETING OF CENTRAL-STATION MANAGERS.—During the present week from June 3 to 8 managers of properties of H. L. Doherty are meeting in Denver to discuss public policy, welfare and kindred topics. The program of the meeting has been arranged by Mr. C. N. Stannard, secretary of the Denver Gas & Electric Light Company.

* * *

LIFE OF LORD KELVIN.—Publication No. 13 of the Central Office of the International Electrotechnical Commission is a monograph by Prof. Silvanus P. Thompson containing in 37 pages a brief history of Lord Kelvin's life, and especially of his scientific life. Like all Professor Thompson's writings, it is forceful, clear and convincing. It is the best short account of Lord Kelvin's career which has yet been published, and it has been distributed among all the national committees of the International Electrotechnical Commission, of which Lord Kelvin was the president in 1906. Like all such official documents of the commission, it is printed in both English and French on alternate pages.

* * *

LAND PURCHASED FOR POSSIBLE LARGE GENERATING PLANT IN SOUTH CHICAGO.—The Commonwealth Edison Company has purchased a 22-acre tract of land in the southeastern part of Chicago lying on the east side of the Calumet River between Ninety-eighth and One Hundredth Streets and not far from Lake Michigan. It is not unlikely that a large electric generating station will be built on this site at some time in the future, as the location of a possible southern power house has been under consideration for several years. Chicago's major axis is from northwest to southeast, paralleling the shore of the lake. The electric-service company has now two large generating stations near the center of this line and one in the northern portion of the city. A southern power house would balance the production of energy in a geographical sense, and probably a station will be built on the South Chicago site when the demand warrants.

* * *

ELECTRIC VEHICLE PARADE.—One of the largest parades of electric trucks and commercial vehicles ever held took place at Boston on May 30 under the auspices of the Electric Vehicle Club, 125 machines being in line, a total doubling that of a year ago in the same city. The parade was organized in seven divisions, President Day Baker of the Electric Vehicle Club being chief marshal. All the principal makes of electric trucks and commercial wagons represented in Boston were featured, and a noteworthy display of electric vehicles was made by the Boston Edison Company, the Cambridge Electric Light Company and the Malden Electric Company also being participants. The Massachusetts Society for the Prevention of Cruelty to Animals operated an electrical ambulance with a handsome horse aboard, and the coal, lumber, bakery and other establishments represented by trucks and delivery wagons carried full loads of their products.

* * *

ELECTRIC POWER FROM THE MISSISSIPPI.—The Mississippi River Power Company, of Keokuk, Ia., of which Mr. Hugh L. Cooper is vice-president and chief engineer, has issued an unusually interesting illustrated pamphlet of sixty-one pages, entitled "Electric Power from the Mississippi River." The book gives a condensed but comprehensive description of the work in progress in developing the water-power of the Mississippi at Keokuk. While it is intended for both engineers and laymen, it is written in non-technical language. One section of the pamphlet is devoted to "Incidents of Construction" and contains a description of the method adopted to protect the cofferdams inclosing the power house and canal-lock site from damage by ice in the spring of this year. The plant, it is promised, will be in operation not later than July 1, 1913. A description of the project and data on the progress of the construction work were given in the *Electrical World* for April 13, 1912, page 788.

* * *

ILLUMINATION AT GALVESTON CAUSEWAY CELEBRATION.—In connection with the celebration attendant upon the opening of the new Galveston causeway, and as a part of the movement to make Galveston "the best lighted city in the world," the Brush Electric Company, of that city, recently arranged an elaborate electrical display, the largest of its kind in the Southwest. The entire building of the electric company, a three-story structure, was illuminated, about 2000 tungsten lamps being used. Some 30 per cent of these were in five colors. On the front of the building for outline and ornamental effects two large onyx Roman columns with flaming torches extended from the ground to the cornice, across which were two large designs giving the effect of marble. Between these was "the Lone Star of Texas," which changed in color from white to red, red to green and green to yellow, this cycle then being repeated, green rays flashing from the star with each of the color changes. The turning on of the illumination, which cost $2,500, was made the occasion for a local demonstration of considerable magnitude.

* * *

N. E. L. A. INDUSTRIAL LIGHTING.—Among the most valuable publications on the subject of lighting for mills and factories is the 64-page book, "Modern Industrial Lighting," issued by the commercial section of the National Electric Light Association. While the purpose of the book is instruction of central-station solicitors, its text and data are of such practical and non-technical nature that it will also appeal strongly to mill and factory managers. Being entirely independent of any manufacturers, its value both to the industry and to the layman is considerable. The book contains chapters on "The Arguments in Favor of Good Lighting," "Design of Industrial Lighting Installations" and "Industrial Lighting Practice." The first two chapters are illustrated with pictures showing model installations under artificial light and daylight. The chapter on "Lighting Practice" is illustrated with diagrams and tables in which the location, desirable intensity of light, type of lamp and reflector, etc., are set forth in detail. "Modern Industrial Lighting" will be sold to non-members of the National Electric Light Association, though its primary purpose is to give to the commercial section of that association the necessary working data for interesting mill and factory managers in the economy and desirability of modern illumination.

Central-Station Service in Hotels.—The superiority of central-station service for certainty of operation and reduction of labor troubles was demonstrated this week in New York when the engine-room force of the Hotel Netherland walked out in sympathy with the strike of hotel workers in the city.

* * *

Armour Institute Alumni Association.—About 160 attended the annual spring meeting and banquet of the Alumni Association of the Armour Institute of Technology at the Hotel Sherman, Chicago, on May 28. Mr. William T. Dean, of the Chicago office of the General Electric Company, was toastmaster at the dinner and there were a number of interesting features, including an instructive illustrated lecture by Mr. Hugh L. Cooper, vice-president of the Mississippi River Power Company, on "The Keokuk Dam." Mr. L. A. Hawkins, of the research laboratory of the General Electric Company at Schenectady, gave an address on industrial research, and there were speeches also by Messrs. Harold F. McCormick, B. J. Arnold and R. Neufeld. Mr. F. M. de Beers, president of the association, awarded the president's cup to the class of '99 as having the largest percentage of its members at the annual meeting. Mr. Frederick U. Smith, secretary of Armour Institute, was present as the official representative of the faculty.

* * *

Electric Pumping in Chicago Water-Works Station.—After a service test of the electrical operation of the Twenty-second Street pumping station of the Chicago water-works, the city of Chicago has entered into a contract with the Sanitary District for the electrical energy needed. The plant was described and illustrated in the *Electrical World* of April 27 last, page 905. The city agrees to pay $2.20 per hp of the maximum requirements for each month, with the privilege of using the service any part or all of twenty-four hours a day. The maximum demand is determined by the average of the three highest five-minute readings taken from a curve-drawing instrument. In addition the city will pay a flat charge of $210.56 a month to cover fixed charges of investment and maintenance of the underground transmission line to the pumping station. Energy is furnished at 12,000 volts, 60 cycles, to two synchronous motors, each rated at 1000 hp and directly coupled to a centrifugal pump. The contract is for the term of six years from Feb. 1, 1912.

* * *

Turbo-Generator of 25,000-kw Rating.—Brief data concerning the 25,000-kw turbo-generator being built by Messrs. Parsons, England, for the Commonwealth Edison Company, of Chicago, were presented in a paper on "Electricity Supply: Past, Present and Future," read before the Royal Institution of Great Britain by Mr. A. A. Campbell Swinton at a meeting on April 19. This interesting machine will be of the horizontal type, and the steam turbine will be divided into two parts. The rotor in the high-pressure end will be equipped with blades made of copper, which is better suited to withstand super-temperature than the usual bronze. The high-pressure exhaust is carried to the center of the double-flow, low-pressure end where it divides and flows in opposite directions. The condenser has a total cooling surface of 39,000 sq. ft. and is made part of the machine in order to avoid all losses in connecting pipes. The rated speed will be 750 r.p.m. with an unusual steam pressure of 200 lb. per sq. in. at 200 deg. Fahr. of super-temperature. The generator end will be capable of delivering a continuous output of 25,000 kw at unity power-factor. This generator will be wound for 4500 volts at 25 cycles. The generator voltage will be raised to the system pressure of 9000 volts by means of a 2-to-1 ratio auto-transformer designed also as a power-limit reactance.

SOCIETY MEETINGS.

Philadelphia Section of the A. I. E. E.—At the closing meeting of the Philadelphia Section of the American Institute of Electrical Engineers on June 10 the general topic for discussion will be the electrical features of the Panama Canal. Papers dealing with various phases of this subject will be presented, as follows: Morris E. Leeds, *Panama Before the Canal;* Carl W. Sherer, *An Illustrated Description of the Canal;* J. Franklin Stevens, *Social Features of the A. I. E. E. Trip to the Canal,* and Dr. Carl Hering, *Odds and Ends.* The meeting, which will be held at the Engineers' Club, will be preceded by an informal dinner.

* * *

Mississippi Electric Association Convention.—At the conclusion of the fourth annual convention of the Mississippi Electric Association, held at Vicksburg, Miss., from May 28 to 30, the following officers were elected for the ensuing year: President, Mr. R. B. Clagett, Greenville; vice-president, Mr. W. F. Gorenflo, Gulfport; secretary, Mr. A. H. Jones, McComb; executive committee, Messrs. F. J. Duffy, Natchez; A. B. Patterson, Meridian; S. M. Jones, Laurel. No decision was made concerning the next meeting place, but pressing invitations have been received from Hattiesburg, Natchez and Jackson. A committee was recommended on a bill of public utilities, another to report on the standardization of line construction matters, and a third to report on public policy, insurance and employees' compensation. The convention concluded with a banquet at the National Park Hotel on May 30. Abstracts of the papers and discussions will appear in a later issue of our paper.

* * *

Minnesota Electrical Association Convention.—Arrangements have been made for holding the sixth annual convention of the Minnesota Electrical Association in connection with the fourth annual Northwestern Electrical Exposition in Minneapolis during the week of March 15-22, 1913. It is expected that a meeting of the Minnesota Section of the A. I. E. E. will be held in Minneapolis during the same week, and that there will also be a meeting of the Minnesota Electrical Contractors' Association and a rejuvenation of the Sons of Jove at the same time. The meetings of the Minnesota Electrical Association will cover three days, those of the Minnesota Section of the A. I. E. E. will cover two days, and those of the Minnesota Electrical Contractors' Association will cover two days. The meetings and exposition will be held in the Coliseum, which is now in process of erection. The manager of the exposition is Mr. R. W. Clark, assistant commercial agent of the Minneapolis General Electric Company.

* * *

Convention of Heating Association.—Among the papers to be presented at the fou.th annual convention of the National District Heating Association, Detroit, June 25, 26 and 27, will be the following: *Common Sources of Trouble in Customers' Installations,* by William E. Darrow, Indianapolis; *The Quality of Steam as Served by Central Stations to Their Customers,* by A. C. Shepherd, Cleveland, Ohio; *An Analysis of Heating Rates,* by A. E. Duram, Chicago; *Heating in Connection with Steam Turbines,* by A. H. Kruesi, Schenectady; *Description of Combined Heating, Refrigerating and Power Plant of Murphy Power Company,* by J. F. Lewis, Detroit; *Description of a Large Hot-Water-Heating System,* by G. E. Chapman, Chicago; *District Steam Heating in Chicago,* by S. M. Bushnell, Chicago, Ill.; *Depreciation in Underground Distribution Systems,* by William Jennings, Harrisburg, Pa.; *Economic Survey of Combined Power and Heating Plants,* by E. D. Dreyfoos, Pittsburgh, Pa. The convention headquarters will be at the Cadillac Hotel. The president of the association is Mr. A. D. Spencer; the secretary is Mr. D. L. Gaskill, Greenville, Ohio.

ELECTRICAL EQUIPMENT OF THE AUSTRIAN STATE RAILWAYS.

Generating, Distribution and Rolling-Stock Equipment for Single-Phase Operation at 25 Cycles.

Parallel Operation of Six Generating Stations Driven by Water Turbines, Steam Engines, Gas Engines and Diesel Engines—Distribution at 6,500 Volts and 27,000 Volts.

THE mountain railway between St. Pölten, in Lower Austria, and Mariazell, Styria, is a branch of the Austrian State Railway. It is notable in that it is the first electric railway in Austria which is equipped on a large scale for locomotive operation, and, although the road is a narrow-gage one (30 in.), it carries a very heavy passenger and freight traffic. The road was originally intended for steam operation. In 1907 it was operated entirely by steam locomotives.

The total length of the branch is 51 miles and it contains many severe grades. At St. Pölten, Laubenbachmühle and Mariazell large passenger stations have been erected. In addition to these there are seventeen smaller stations along the line and ten stopping points where passengers are taken on. The terminal station at St. Pölten is 850 ft. above the sea level. The station at Laubenbachmühle is 1700 ft., that at Gösing is 2900 ft., that at Wienerbruck 1750 ft., that at Mariazell 2800 ft., and that at Gusswerk, which is the other terminal, 2450 ft. The track is laid with rails 34 lb. per yard in the stations and 44 lb. per yard in the open. The smallest radius of curvature is 260 ft., and the steepest grade is 2.5 per cent on a curve between Laubenbachmühle and the Gösing tunnel. The road for the most part runs through very mountainous country, which requires the building of the many tunnels and bridges. Altogether there are 136 small and nineteen large culverts, with a total length of 3500 ft. These are constructed partly of stone and partly of steel. Altogether there are nineteen tunnels, having a total length of 13,000 ft. The longest one, the Gösing tunnel, is 7750 ft. long. It is located at the highest point on the railway line, namely, 2900 ft. above the level of the sea.

The St. Pölten-Mariazell Railway was opened in May, 1907, and the traffic increased more rapidly than it could be handled. During the first year 532,000 people and 127,000 tons of freight were handled. This traffic continued to grow until it became practically necessary to introduce electric motive power in order to handle it, the electric energy being generated for the most part in hydroelectric plants. The water-power is derived from two falls, one at Wienerbruck and the other at Trübenbach. It is planned to develop a third fall at Urmannsau. In order to provide for periods of low water a standby station equipped with two directly connected 800-hp Diesel oil engine units has been erected at St. Pölten.

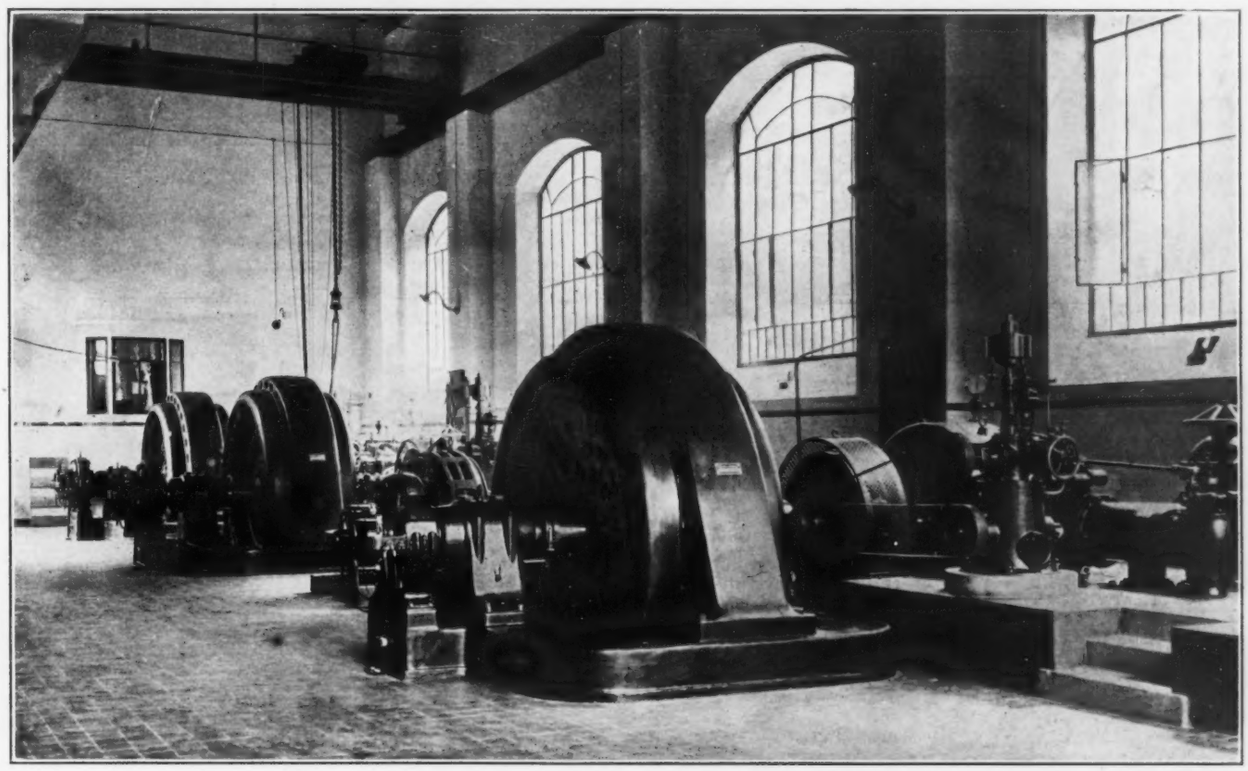


Fig. 1—Interior of Wienerbruck Power House.

The three above-mentioned stations also furnish electric energy for light and motor service to be distributed to points along the line of the railroad. The largest consumer of this energy is the central station in St. Pölten. This company operates three power plants of its own and distributes energy to various factories in St. Pölten and also to a small railway between St. Pölten and Narland. The three plants of the Elektricitätswerke and the three plants of the railway system are all operated in parallel, making an aggregation of prime movers including water turbines, steam engines, gas engines and Diesel engines. The distribution circuit is three-phase and operates at 5000 volts, 25 cycles.

In order to be able to use the same machines for the three-phase distribution and for the railway, it was necessary to adopt 25 cycles for railway operation. The generators in all of the power stations are of the three-phase type, arranged so that they may be connected either to the single-phase railway distribution system or the three-phase general distribution system.

WIENERBRUCK POWER HOUSE.

In the development of the first fall, where there is an effective head of 560 ft., a power house was erected at Wienerbruck, which lies in a deep ravine on the Erlauff River. In this power house there are three 1000-hp, 375-r.p.m. turbines, which were erected by the firm of J. M. Voith in St. Pölten. These turbines are directly connected through couplings to the generators. The fourth unit of 2000 hp will be installed later.

In order to equalize the flow of water there have been provided a reservoir over Lassingbach, at the Wienerbruck station, having a capacity of about 300,000 cu. m, and another over the Erlauff River, at the Erlauff station, having a capacity of about 2,600,000 cu. m. From these reservoirs the water is conducted to turbines through pipe lines of 3 ft. and 3.6 ft. diameter respectively.

The generators are 6500 volts, three-phase, and are rated at 1340 kva, three-phase, or 900 kva, single-phase. The new unit will be equipped with a generator having a rating of 2600 kva, three-phase, or 800 kva, single-phase. The rating of the generators was so chosen that with a single-phase load and a load-factor of 0.8, they would impose full load upon the turbine of 1000 hp and 2000 hp respectively.

Each generator is provided with a directly connected, shunt-wound exciter, and in addition there is one independent excitation unit driven by a 50-hp, 1000-r.p.m. turbine. The switchboard is installed in the gallery at one side of the machinery. Behind the switchboard are placed the high-tension conductors, switches and protective apparatus, so arranged that it is impossible to come accidentally in contact with them. The generators are connected to the switchboard through cables. In the upper part of the switch room are installed the lightning arresters and the water-jet grounding apparatus for the outgoing lines.

The line potential is maintained constant by automatic

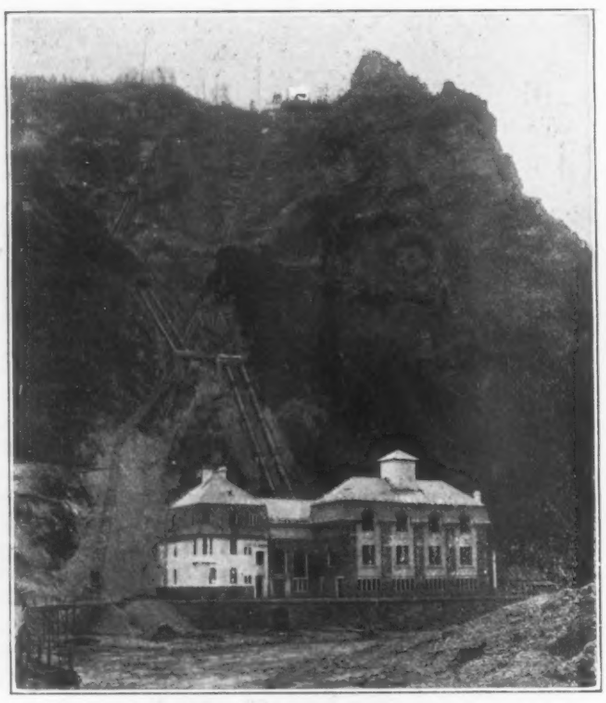


Fig. 2—Exterior of Wienerbruck Power House.

Dick regulators on the exciters. These regulators are operated from series transformers connected in the outgoing lines. To prevent excess action of the regulator in case of short circuits, etc., the feeders are equipped with overload time-limit relays, the function of which is to disconnect the Dick regulator.

The transformer room below the switching room contains three 6500-27,000-volt, three-phase transformers immersed in oil and equipped with water-cooling coils operating three-phase. They are rated at 1350 kva, and single-phase at 900 kva. A special transformer is installed for the lighting of the station.

TRÜBENBACH POWER HOUSE.

The second fall is developed at Trübenbach, above which

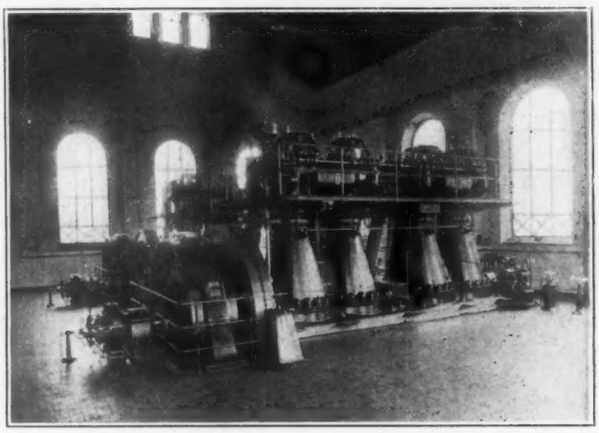


Fig. 3—Standby Station at St. Pölten.

there is installed a reservoir having a capacity of about 700,000 cu. m., which collects water from the Wienerbruck station and also from Oetscherbach. From the reservoir the water is conducted about 2.5 miles through penstocks and pipe lines to the turbines. The effective head is 390 ft.

The Trübenbach power house differs from the Wienerbruck plant principally in that it is designed for three-phase operation exclusively. It is equipped with two 1200-kva directly connected generators. The switching apparatus is similar to that used in the Wienerbruck power house. The machine voltage of 6500 is stepped up to 27,000 volts by two three-phase transformers, each being rated at 1200 kva. The third fall of the Erlauff River will be developed at Urmannsau. The equipment will be similar in all respects to that at Trübenbach.

STANDBY STATION.

At St. Pölten a standby station has been erected to help out the hydroelectric stations during periods of low water and also to act as an emergency station. This station is equipped with two 800-hp, four-cylinder, 167-r.p.m. Diesel oil engines directly connected to the generator. The generators are provided with directly connected exciters and have a rating of 700 kva, three-phase, 420 kva, single-phase, at 25 cycles and 5000 volts, and with a power-factor of 0.8 require 835 hp to drive. In this station the 20,000-volt lines from Wienerbruck to Trübenbach are connected to the primaries of the distribution transformers which feed the 5000-volt circuits of the city system. This transformation is accomplished with a three-phase transformer immersed in oil and water-cooled, having a continuous rating of 1000 kva, three-phase, or 580 kva, single-phase. A second transformer of the same size will be installed later. The secondary of the transformer is connected in parallel with the station busbars.

DISTRIBUTION SYSTEM.

The energy for the operation of the section between Wienerbruck and the 46-mile post is supplied over a 6500-volt feeder, having a cross-section of 136,000 circ. mils, from the Weinerbruck power station. The other sections are fed from transformer stations in Kirchberg and Ober-Grafendorf, which are connected to the Wienerbruck power station through 27,000-volt, single-phase feeders, having a cross-section of 97,000 circ. mils, from the Wienerbruck station. These feeders have a section of 97,000 circ. mils

up to the Kirchberg station and from there to the Ober-Grafendorf substation they have a cross-section of 68,000 circ. mils. From the Ober-Grafendorf substation a 68,000-circ. mil feeder leads to the standby station in St. Pölten, so that in case of an emergency the road can be fed from that station.

In addition to the single-phase line between the Wienerbruck power station and St. Pölten, there is a three-phase, 27,000-volt line for general distribution, which consists of three wires having a cross-section of 68,000 circ. mils. This three-phase line passes through both transformer substations and by suitable switching equipment is arranged so that in case of accident to the single-phase lines the three-phase lines can be connected to the railway distribution circuit. All high-tension lines are insulated with delta insulators which have been tested at 75,000 volts. All lines follow the road, with the exception of those from the Wienerbruck and Trübenbach power stations to the 46-mile post and 41-mile post respectively, and the short cuts between 44 and 45 miles and between 31 and 39 miles, and the lines around the tunnels. All poles are grounded by connection either to the rails or to a galvanized-iron wire 2.7 in. in diameter which is clamped to the poles and connected to ground plates at frequent intervals.

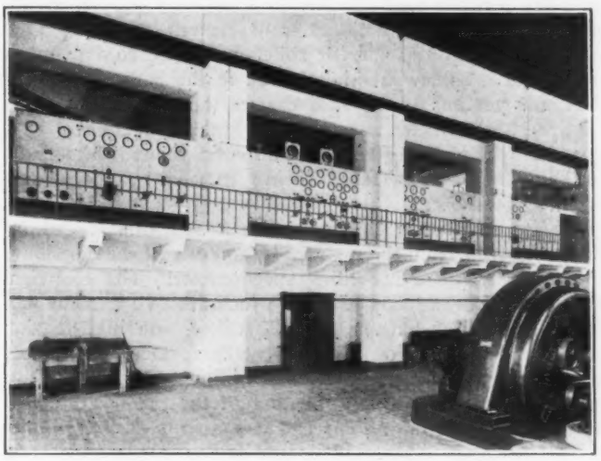


Fig. 4—Switchboard Gallery at Wienerbruck.

In order to insure the grounding of a broken transmission wire, a galvanized-iron ground ring supported by short iron arms surrounds each conductor at a short distance from the insulator, as is shown in the illustrations. Because of the perfection of this method of protection, no other means is employed at highway crossings and at other places where the pole spacing is less than 49 ft. At crossings greater than 49 ft., however, ground nets were used. At the crossing over the Reichsstrasse in St. Pölten, in accordance with ordinances of the town, a wire bridge net completely incloses the line. The high-tension lines are protected against potential rises and lightning strokes by arresters installed at the power stations and substations where they are under constant observation of the attendants. Heavy strokes are taken care of by spark-gap arresters set for a given maximum potential. For the continuous discharge of small potential rises, water-jet ground connections are installed. Resistors are connected in series with horn lightning arresters so as to limit the discharge current. The magnitude of the resistance is chosen small enough to prevent serious reduction of protective value of the horn gap and large enough to prevent formation of destructive arcs in the gap and thus prevent the setting up of surges.

KIRCHBERG AND OBER-GRAFENDORF TRANSFORMER SUBSTATIONS.

The high-tension lines enter the substations through the side walls and are connected on the inside to a disconnecting switch, which is operated only when carrying no load. Two oil-insulated, self-cooled single-phase transformers having a continuous rating of 900 kva are installed in each station. In order to take care of the increased traffic a third substation will be erected at Laubenbachmühle and equipped with transformers of the same size as used in the other substations. In this way all transformers are interchangeable. Circuits are controlled by automatic oil switches equipped with time relays. If a high-tension circuit-breaker opens, an alarm is sounded in the attendant's room and an annunciator indicates which switch is open. An indicator in connection with an alarm is also used to warn the attendant when the temperature of the oil in any one of the transformers rises above a certain value.

The oil switches on the high-tension side of the transformers are equipped with resistance steps which prevent a sudden application of full emf to the transformer. Also, when disconnected, these resistors serve to reduce the inductive effect.

The working conductor is fed from the substations, there being two feeders from each station, one extending in each direction. The working conductor is divided by section insulators at the substations and at the feeding points between the substations. Under normal conditions the section insulators are short-circuited through a switch, thus tying the whole system together.

OVERHEAD DISTRIBUTION SYSTEM.

The working conductor is suspended from a compound catenary. It is of hard copper, has a cross-section of 154,000 circ. mils, and is supported at intervals of 10 ft. by clamps loosely hung on the auxiliary catenary. The auxiliary catenary is a steel wire 0.24 in. in diameter suspended from the main catenary at intervals of about 2.5 in. by hangers which are rigidly attached at both ends. The main catenary is a seven-strand steel cable having a total cross-section of 68,000 circ. mills. In the tunnels where there is much moisture bronze is substituted for steel in the catenary construction. The working conductor is prevented from swinging by gas-pipe braces insulated with two petticoat insulators in series, as shown in the illustrations. On curves the braces are so arranged that they are always under tension. The height of the working conductor over the top of the rail is 18 ft. in the open. An even tension is maintained on the trolley wire by inserting an automatic tension device at intervals of about 0.6 mile. The construction is carried by iron poles either of the gitter type of construction or of broad flange I-beams. In the open where there is only one track the catenary is carried on brackets, the poles being spaced at 165 ft. In the stations where there are several tracks the overhead work is carried

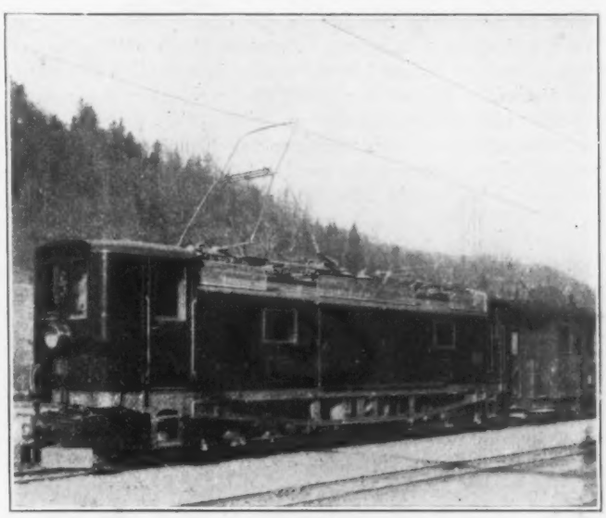


Fig. 5—600-hp. Single-Phase Locomotive.

by a channel iron supported by two poles. All poles are grounded to the rails.

In the tunnels special construction had to be used in order to carry out the compound catenary type of construction within the clearance limits imposed by the profile of the tunnel. The maximum height of the tunnel over the rails is 1135 ft., and the height of the clearance profile is 12 ft. over

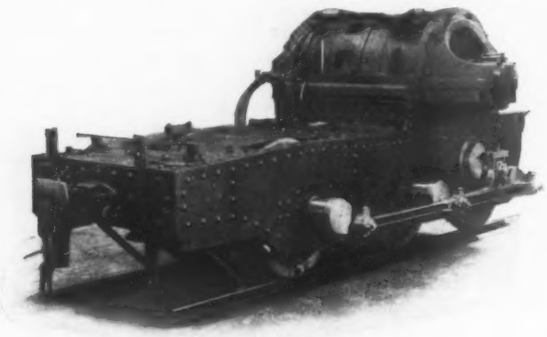


Fig. 6—Motor Truck for Locomotive.

the top of the rails. Therefore there is only 1.5 ft. available for the overhead construction. The working conductor was brought within 2 in. of the clearance profile—that is, 12 ft. over the top of the rail—and the construction was supported at intervals of about 60 ft. by three-part insulators mounted in the upper part of the tunnel walls. One of the advantages of mounting insulators on the side walls was the freedom from trouble due to locomotive smoke during the period when steam locomotives were still used on the road.

The overhead conductor is provided with a section insulator at both ends of all tunnels and at all stations so that these portions of the road can be isolated in case of trouble. Then, in order not to interfere with the operation of the road as a whole, by-pass lines are carried around the tunnels and around the stations. The switches connected to these by-pass lines are mounted on the poles and operated from the ground by rods. The section insulators themselves are carried by two brackets spaced about 33 ft. apart, between which two working conductors are strung parallel to each other and about 1 ft. apart. Between these points the two conductors are inclined horizontally in opposite directions, and therefore in passing along the conductor the current collector is transferred from one to the other without shock. At stations section insulators are very much simplified, and instead of overlapping the sections, as described above, the insulator is built right into the line itself.

ROLLING STOCK.

The motive power equipment consists of fourteen 47-ton locomotives. They will draw a 100-ton train at 25 miles per hour on a 2.5 per cent grade. The normal acceleration is about 1 ft. per second per second.

The locomotives are of the double-truck type, which are especially adapted to the development of large amounts of power on short radius curves and to high-speed operation. Each of the trucks is provided with three driving axles coupled together by side rods. The cranks on one side are displaced 90 deg. from those on the other. All cranks and revolving weights are perfectly balanced. The center of gravity of the motor lies high up between the middle and the end axle.

The truck side frames are made of steel plates which are connected at the front by the draft gear, at the back by a transom and in the middle by the jack shaft and the motor frame. Each truck is equipped with an alternating-current series motor which is rated at 300 hp. with 220 volts, 25 cycles and 700 r.p.m. It is self-cooled and has no preventive resistance leads in the commutator connections. The gear ratio is 1 to 3. The wheel pressure is approximately 4 tons. The weight of the motors exclusive of the gears, gear case and jack shaft is in round numbers 10,000 lb. The gears run in oil which is carried in the gear case. The king pin is relieved of weight of the locomotive body by two supports mounted on each side.

The locomotive body, which is carried by two side trusses that are securely tied together by cross-bars, carries all the auxiliary apparatus such as transformers, control, equipment, air pump and current collectors. The roof over the vestibules is somewhat higher than in the body of the car. The low portion of the roof carries the current collectors and the high-tension wiring. The braking equipment consists of a hand brake and an automatic vacuum brake, the brake cylinders and tanks being carried by the underframing of the car.

The locomotive is equipped with a Schneider speed indicator driven from the jack shaft, and one of the vestibules is equipped with a recording speedometer. The electrical equipment of the locomotive also includes two current collectors, one high-tension circuit-breaker, one high-tension relay, two high-tension fuses, two transformers, two motor controllers, two air-pump motors, lighting and heating apparatus. The lighting and heating of the train is supplied by means of alternating current at 220 volts.

Two directly connected motor-driven air pumps, one large and one small, generate a vacuum for the automatic brakes. The brake control and the motor control are so interlocked that when the brakes are applied the motors are automatically disconnected and the motors cannot be started until the brake lever is in the starting position. In this way the motors are protected from an overload.

The raising and lowering of the current collector may be accomplished from either vestibule by means of a manually operated hoist. The drum of the current-collector hoist is operated by means of a crank handle that can be removed

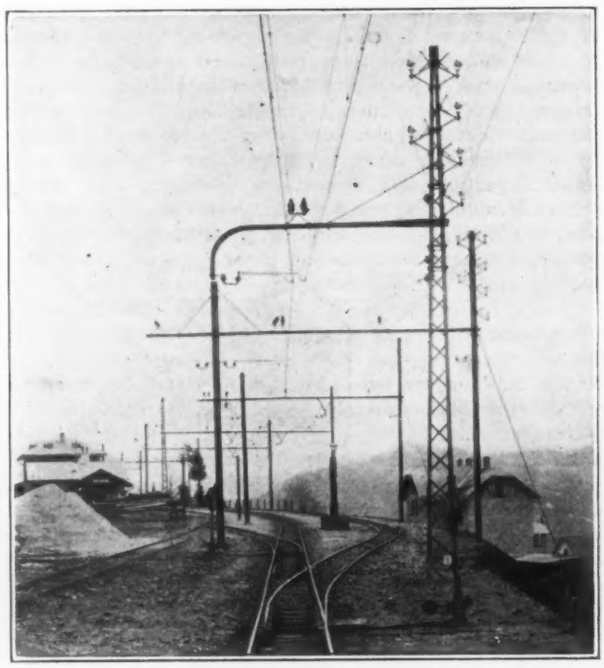


Fig. 7—Overhead Distribution.

only when the current collector is in its lowest position. This same lever is used to close all the doors of the high-tension compartment and transformer compartment, and it cannot be removed from the compartment doors until they are closed and locked. Therefore the current collector can never be raised when the high-tension compartments are open.

The total electrical equipment of the locomotive weighs approximately 23 tons and the mechanical part 24 tons. The maximum tractive effort at the rim of the drivers is in round numbers 10 tons. The drawbar pull with a 100-ton train on a 2.5 per cent grade is approximately 5 tons.

As was mentioned before, the profile of the road imposes an exceedingly difficult service upon the locomotive. Beginning at St. Pölten to the 30-mile post, there is an average grade of 1.2 per cent; from the 30-mile post to the 41-mile post the grade is 2.5 per cent; from the 41-mile to the 45-mile post it is 2.5 per cent down grade; from the 45-mile to the 56-mile post, the terminal of the road, it is up and down grade with some grades as great as 2.5 per cent. Fifty per cent of the total length of the road is made up of curves of radii between 250 ft. and 300 ft. In the winter time operation is made very difficult by heavy snowstorms.

ELECTRIC IRRIGATION PUMPING IN SOUTHERN CALIFORNIA.

Operating Experiences of Pumping Plants in the Pomona District—About 125 Electrically Driven Plants Within a Radius of 10 Miles.

THE importance of water conservation is one of the most striking truths which the observing visitor to the Far West carries homeward after a trip through the great commonwealths of the Rockies and the Pacific Slope. The contrast between land fit only for the raising of sagebrush on the "sky-farming" principle of waiting for rain for weeks and months at a time and the similar areas rendered fertile through irrigation becomes a permanent mental possession of the visitor who sees for the first time what an efficient water supply means to the great trans-Mississippi empire growing to maturity within our common republic. There is nothing new in the dependence of arid and semi-arid regions upon irrigation. The economic necessity of water presses hard to-day, even as it bore down upon humanity in the dawn of history, but through modern engineering advances the old limitations are rapidly passing away, and a day of flexible application of water is at hand, which means so much to the expanding communities of the Far West that even conservatism hesitates to set limits to its possibilities. It is significant that electricity is a potent factor in this development, and that

Fig. 1—Pomona Substation and Office, South California Edison Company.

the supply of cheap power to motors driving irrigation pumps is literally revolutionizing farming conditions in localities where extensive distribution facilities are available for the application of central-station or hydroelectric service to this new and attractive field.

In the *Electrical World* of Sept. 30, 1911, there appeared an article upon recent developments in electrical irrigation in Colorado, and the important work in this field of the Northern Colorado Power Company was reviewed. Another center of electric irrigation pumping is the Pacific Coast region, a large amount of this work being both planned and in operation by several of the larger power-transmission organizations of the Slope. One of the most highly developed fields of electric pumping is the so-called Pomona

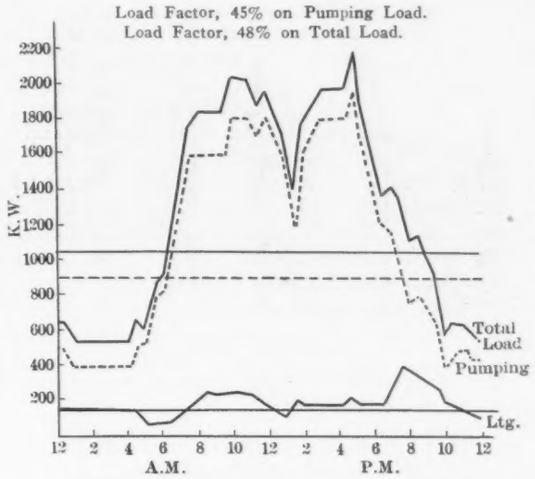


Fig. 2—Load Curves for Pomona Substation.

district of the Southern California Edison Company, comprising the municipalities of Pomona, Claremont, Lordsburg, La Verne, San Dimas, Chino and the Spadra district, and lying in general within a radius of about 35 miles of the city of Los Angeles. In few localities has the use of underground water for irrigation received more thorough study than in the Pomona Valley, which is one of the most noted orange, lemon, citrus and walnut-growing sections of California. Here water has a high agricultural value, but on account of its irregular supply through an uneven rainfall a highly efficient system of irrigation through pumping has become absolutely essential to the welfare of the territory. The hydraulic features of the development have lately been described at length in a bulletin of the United States Department of Agriculture, No. 236, Office of Experiment Stations, under the title of "The Use of Underground Water for Irrigation at Pomona, Cal.," by Mr. C. E. Tait. In the following paragraphs is given an outline of the electric pumping applications of the Pomona district,

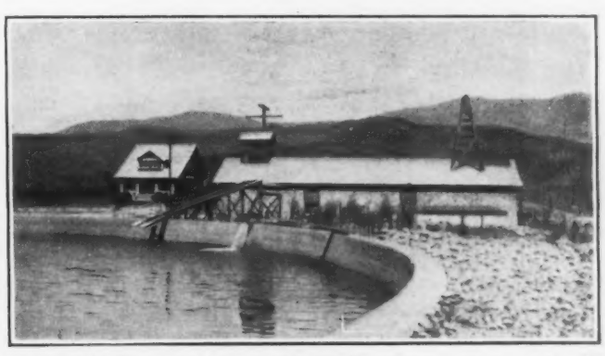


Fig. 3—Electric Plant for Irrigation and Pumping, Near Pomona, Cal.

energy for practically all the motor-driven plants being supplied by the Southern California Edison Company, whose center of distribution for the Pomona Valley is a substation in the heart of the city of Pomona, connected with the general transmission system of the company by two three-phase, 33,000-volt lines.

In general, the land holdings in the Pomona Valley are

small, the predominating sizes being 10-acre orchards and 40 to 80-acre alfalfa farms, bunched together into settlements. Strong rivalry exists between localities, and yet the fruit growers have been ready to co-operate in all movements toward mutual well-being. Active farmers' clubs have been effective in leading to progress in all industrial methods. It has long been appreciated that economy in the use of water lies at the base of the very existence of these communities, and this fact, combined with a high average intelligence, fairly adequate financial resources and unusual possibilities, has led to the existing development. As there is no single source of water at Pomona a large mutually owned irrigation system is not feasible, and the growth of the water supplies has been more natural than in many cases where lands under canal systems have been colonized by special efforts of promoters. Nearly all the water used about Pomona is pumped from wells, and within a radius of 10 miles from the urban center there are over 200 pumping plants, representing an investment of about $1,000,000, with an additional $500,000 invested in distributing pipes and small reservoirs. About 125 of the pumping plants are now operated by electricity, the load falling upon the Edison company's system in practically continuous demands day and night during the seven months of April to October inclusive.

The rainfall at Pomona for the past eighteen years has averaged 18.44 in., but from 75 to 90 per cent of this has frequently occurred in the five months of the rainy season. The total number of acres irrigated in this region is over 20,000. The only important stream in the region is San Antonio Creek, which rises in the San Gabriel Mountains at an elevation of 10,080 ft.

In general the plants in the district are supplied with energy from the local 10,000-volt distribution lines of the Edison company, these radiating from the Pomona substation and being carried mainly along the highways on

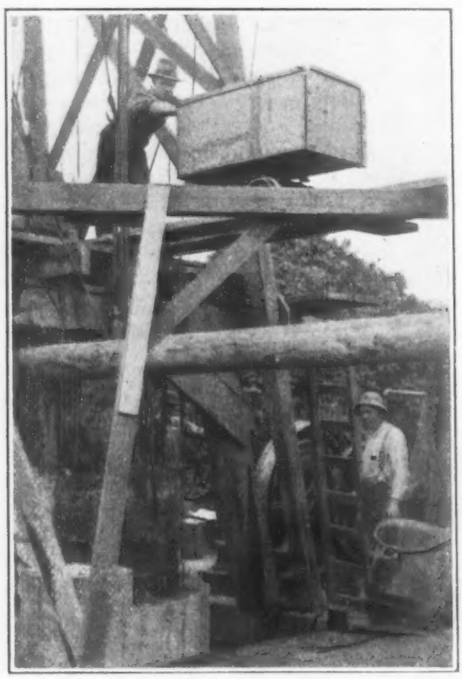
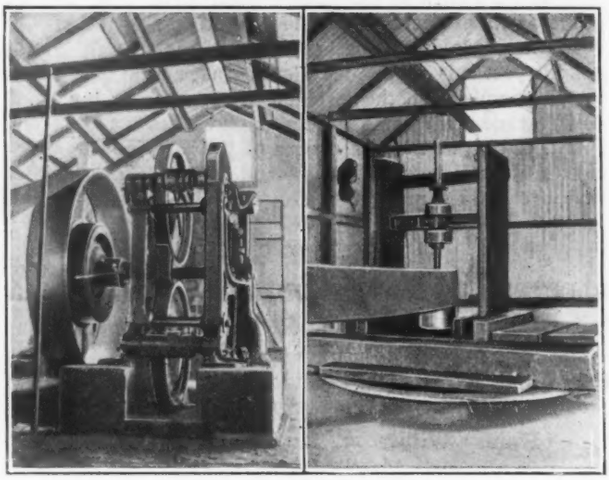


Fig. 4—Sinking Well.

wooden poles. Local transformers are installed to supply power to motors at 440 volts. The pumping and suburban load at Pomona is handled through three 500-kw General Electric transformers, reducing the potential from 33,000 to 10,000 volts for local distribution among the ranches. The load is so well sustained during the irrigation season that the day peak exceeds that in the evening, and a heavy demand is often maintained upon the substation even during the night hours, which are always the most difficult in which to market electrical energy. In addition to the transformer equipment used largely in the irrigation pumping service the substation contains 1050 kw in transformers for general motor and lighting service, the local distribution around the business and residential section of Pomona



Figs. 5 and 6—Pumping Equipments.

proper being at 2300 volts. All incoming and outgoing circuits at the substation are equipped with automatic oil switches opening under overloads, so that the transmission system as a whole is well protected against any unfavorable conditions that may arise on the distribution circuits in the valley. Very little trouble has occurred, however, especially since the company adopted a policy of requiring all pumping plants of modern design to be equipped with overload and no-voltage circuit-breakers in the motor leads. Most of the plants are now provided with this type of apparatus, and in case the water in any well falls below a predetermined level an automatic float attachment is set in operation which opens the motor switch, either by a spring trip on the switch handle or by means of a mechanical connection with the overload release. Usually an electric bell signal is also attached to the motor switch or float mechanism, so that the rancher is promptly notified in case the pump stops. The placing of no-voltage release switch connections in the pumping plants has been of much aid to the company in starting its system after an interruption of service on the hydroelectric lines elsewhere in the southern district. Without these no-voltage release coils the company experienced much difficulty in starting the system's operation, since in this case the throwing of current on the lines required the immediate assumption of a dead load of standing motors and pumps scattered over a great area. With the no-voltage release connection each pump operator starts his own machinery after an interruption, and in the meantime the company's power station and substation operators provide for rapid resumption of service. The company has also found that the use of the overload and no-voltage release coils has been of much aid in preventing the burning out of motors, the older plan of installing fuses only in the three legs of the circuit being unsatisfactory on account of the tendency of the motors to operate on two phases and become overheated in case of a blown fuse on a single leg.

The pumping plants are designed for both deep-well and low-lift service, depending upon the locality and water conditions. Usually the 10,000-volt three-phase line is brought into the building through a monitor at the top, with appropriate vitrified duct bushings, and in the best plants the wiring is protected from short-circuits by liberal spacing of conductors, the pump owner also being safeguarded by

locating all high-tension contacts, insulators and leads well out of reach. Sometimes the step-down transformers necessary for each installation are placed in a bay of the pump house and screened from the motor, switchboard and pumping equipment.

The part of a pumping plant that is most difficult to obtain is the well, and not the machinery. The early deep wells were built with 7-in. casings, but in the present work wells from 14 in. to 24 in. in diameter are driven. The larger sizes are more suitable for the use of both deep-well and centrifugal pumps, and give a larger area for the water to enter the wells from the gravel strata. Wells are bored much deeper than formerly, for with a changing ground water level it has been found desirable to penetrate several good water-bearing strata. The usual method of installing is to employ a standard water rig with drill and sand bucket, the casing being forced down to follow the excavation by hydraulic pressure, often reaching 100 tons. The walls are incased with a double thickness of riveted steel in lengths of 2 ft., placed with broken joints. At the bottom of each well a so-called starter is used, with a steel shoe to promote penetration, and for a length of 20 ft. a riveted sheet-steel tube of treble thickness is used, the parts of the well tube being slotted with the edges bent to give the narrowest opening outward to prevent clogging at the water-bearing strata. Up to 500 ft. the cost of drilling averages from $1.25 to $2.25 per foot.

Centrifugal pumps are used on the shorter lifts, these being as a rule of the vertical type with closed runners balanced by a distribution of the head over unequal areas on top and bottom of the runner to overcome the weight of the runner and the shafting above. The common sizes are 4-in. and 5-in. pumps, frequently fitted with 10-in. discharge pipes and with as large suction pipes as will enter the casing, thereby reducing piping friction. The pumps are each provided with a water seal at the stuffing box to prevent air leaks. The pumps are placed at the bottom of open shafts excavated as deep as the ground water will permit, these being 6 ft. or 7 ft. square or in diameter and curbed in the former case with redwood and in the latter with concrete. The latter type of curbing is now generally adopted on account of the short life of wood. A representative well is one of Consolidated Water Company's equipment, supplying the city of Pomona with domestic water in connection with four other pumping plants operated by electricity. The well is circular, 60 ft. deep and 6 ft. in inside diameter, with a 6-in. curbing of reinforced concrete. The reinforcement consists of twisted steel rods laid both vertically and horizontally, with a spacing of 18 in. The curbing was constructed on top of a steel shoe and lowered with the excavation, the weight of the curbing being supported on steel cables fastened to the shoe at the bottom and passing through the concrete walls to the timber used at the top to carry the load. The forms used are sectionalized steel plates. A typical well of the water company is provided with a 20-hp, 440-volt, three-phase induction motor driving by belted connection a 5-in. vertical-shaft centrifugal pump located at the bottom of the well. The motor is located on a concrete foundation at the ground level and is housed in a neat stone structure with galvanized-iron roof and equipped with starting compensator, meters and overload and no-voltage release switch. The pump house is 32 ft. x 10 ft. and is provided with a 40-ft. derrick at the top, outside, so that machine parts can be handled both inside and outside the well with ease. In most cases the galvanized-iron roofs of the pumping plants in the district are sectionalized, so that they may be removed entirely from the space over the wells, greatly facilitating the handling of the pumping equipment. The Consolidated company's well above mentioned is piped to the main distributing reservoir of the city and also connected with the main 10-in. gravity feed line from the Claremont section, so that in case surplus water is available it can be fed through the well into the water-bearing strata surrounding, or else pumped electrically from the well to the reservoir.

The deep-well pumps used raise water by means of plungers working in a cylinder attached to the bottom of a discharge pipe, the whole of which has been lowered into the well until the cylinder remains under water while pumping. The pumps are double-acting, and two plungers are worked in one cylinder by rods connecting with a power head at the top of the well. A solid rod connecting with the lower plunger passes inside a hollow rod connecting with the upper one, and both rods pass through a stuffing box at the surface. The pumps are provided with a check valve and an air chamber, the usual sizes being from 7 in. x 24 in. to 10 in. x 36 in., the speed varying from 18 to 30 strokes per minute. The power heads are arranged to avoid the occurrence of a dead center. The usefulness of these deep-well pumps depends mainly upon the condition of the leather in the plungers, which seldom last over two years. The cost of leathers is small, but the work of pulling the rods and plungers for replacement is expensive. The most modern plants, both private and corporate, are equipped with derrick facilities. The deep-well pumps are used mainly where the wells do not produce over 30 or 40 miners' inches of water, especially where the lift exceeds 100 ft. or 150 ft. They are more efficient than centrifugals, but more costly to maintain. Breakage of the plunger rods is common in pumps driven by reciprocating engines operated on distillate, while those run by belted induction

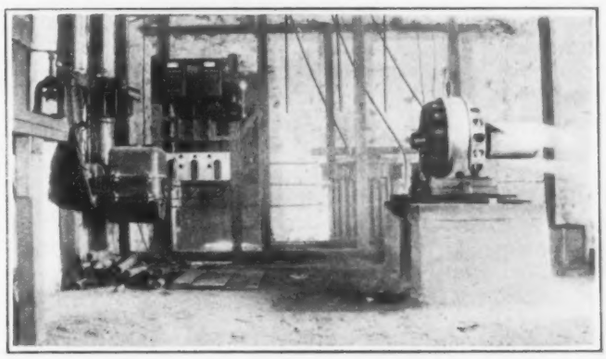


Fig. 7—Typical Motor Installation for Irrigation Pumping.

motors appear to give little trouble. The crystallization caused by the uneven driving of the distillate engine affords a basis for cogent argument in the sale of electrically driven installations. The life of centrifugal pump shafts has also been found much longer with the motor drive, on account of the constant torque exerted. The maximum lift in the district in deep-well pump service is about 400 ft. In general the size of motors used varies from 10 hp to 150 hp.

Steam was the first power used at Pomona for pumping, but electricity is rapidly driving out both steam and distillate engine plants. As present there is but one steam plant in the district, and this is equipped with a 15-hp motor, which is used to operate the pumping apparatus in the long period between irrigation seasons, when it would be impossible to operate the steam-engine installation at reasonable economy. Air lifts, which have been in service for some time, are also being replaced by electrical outfits. The constant attendance required by steam pumping plants has been one of the chief objections to their use. The electric pumping plants require practically no attendance except for starting, and many of these run for five or six months at a time without stopping more than once for an hour or so to enable the owner to make a hasty inspection.

Another reason why electricity is driving out the distillate engine in this service is found in the skilled attention which internal-combustion equipment demands as the price of anything like reliable service. The engines must be oiled at least every six hours, and soon demand repairs.

Their depreciation is extraordinarily high, and when the cost of attendance is considered the installation of electric service is practically assured. Again, the variations in head of water during the season are great, and this makes it practically impossible to secure good economy of operation with the gasoline or distillate plant. It is better for the engines to be run underloaded when not provided with

Fig. 8—Group of Electrically Driven Pumping Plants.

constant attention, and this results in an extreme loss in efficiency. With the electric drive the efficiency may fall off as the load drops, but the reliability of service in no wise suffers, and the superior cleanliness, simplicity and long life of the motor-operated plants have resulted in their increasing installation throughout the district in preference to other motive powers. No adjustments of the motors are required, and the changing conditions of well-water levels are met by substituting various-sized pulleys for those in operation upon a given water table. For this reason the pumping plants are electrically driven through belts rather than gearing or direct connection. It is a striking fact that the cost of fuel is not the greatest expense in pumping. The fuel cost is usually not over 25 per cent of the whole, including the inevitable but often overlooked items of interest, taxes, depreciation, repairs and attendance. The fire risk of the distillate plants is also heavy, and even a small blaze at the beginning of a season is capable of causing such an interruption of service that the crop on the particular area to be irrigated may be ruined. The use of the belt drive reduces the initial cost of machinery somewhat, although offset in a measure by the increased size of building necessary. Belt centers are usually about 25 ft. apart, and the pulleys are large, in order to enable the weight of the belt to prevent excessive slipping, the pull on the bearings also being less than with a short, tightly stretched belt. Centrifugal pumps that need priming are provided at the top of the shaft with a small hand pump connected with the large pump casing by a small pipe. The water is distributed mainly through concrete or vitrified pipes laid underground, with hydrant outlets feeding the ditches. The cost of cement pipe of 1 to 4 mixture at Pomona is given as follows by Mr. Tait:

Size in Inches.	Cents per Foot.	
	Laid.	Unlaid.
8	17	12.5
10	22	16
12	32	22
16	50	35

Ten-inch and 12-in. pipes are laid from private pumping plants for the irrigation of alfalfa. The hydrant outlets of a typical orange grove are 2 in. in diameter, set four at the top of the riser, the latter being 7.5 in. in diameter and about 1 ft. high. The outlets are spaced on quadrants, to provide for the maximum delivery to ditches running in various directions. Cast-iron controlling gates of local manufacture are generally employed on the distributing lines. Reservoirs are largely used by both private and company organizations for water distribution, in order to secure the flexibility of flow necessary in handling diversified crops and at different seasons. The private plant owner whose machinery is operated electrically finds himself possessed of a cheap and yet reliable service which can be utilized whenever needed agriculturally, rather than according to schedule on a fixed date per month and without regard to the necessities of the case.

One of the most representative installations of a private owner is located on the Johnson estate, near Claremont. This plant consists of a deep-well pump driven by a 35-hp, 440-volt induction motor set on concrete foundations, the pump being mounted at the top of a well and having a lift of approximately 230 ft. Water drawn from the underground strata through the well and pump riser is delivered from the pump house into an adjacent concrete reservoir approximately 100 ft. in diameter and about 12 ft. deep, from which drafts are made as required at different points on the estate. Delivery from the reservoir is by gravity. The pump house is a stone building with a monitor at one end, into which the 10,000-volt leads pass, terminating in a transformer compartment at the end below. The usual derrick is provided at the opposite end for handling the pump parts, and the motor is equipped with the usual automatic switching apparatus. By varying the gate opening in the lines leading from the reservoir the owner can adjust the quantity of water to the crop conditions, and the use of the reservoir also enables the pumping plant to operate under steady conditions of demand. More than this, the provision of the reservoir enables much night work to be eliminated in the orchard irrigation, on account of the adjustment of the flow possible in the daytime. Most of the large plants are equipped with weirs. The irrigation of orange orchards is handled by a head in general varying from 60 to 70 miners' inches for best results, and in alfalfa work the head runs from 100 to 200 miners' inches. A small reservoir giving a delivery of 60 miners' inches can be built of concrete for about $1,000. Where pumping plants are installed in a group and owned by friendly interests it is customary to place the transformers in a small corrugated-iron and frame house, with ample provision for ventilation and protection by careful wiring and ample conductor spacing against fire or short-circuits. The motors

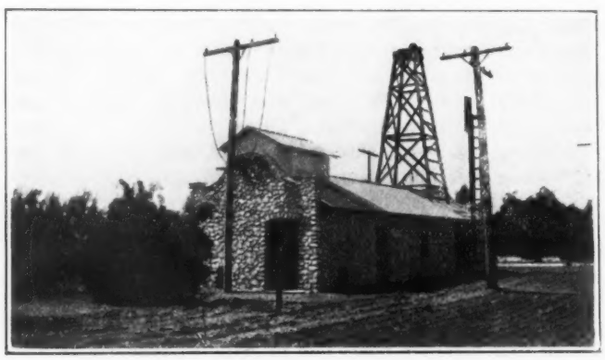


Fig. 9—Typical Electrically Driven Irrigation Plant.

are then supplied with current at 440 volts, over short branch lines carried from the transformer house to the pump houses.

The Edison company sells motors and auxiliary apparatus to ranchers and pumping organizations, and installs the apparatus. Motors are not rented, on account of the difficulty of keeping the installation properly loaded. All motor

services are metered, and these are read monthly by a district foreman, who also makes an inspection of the operating conditions. Troublemen are available at the Pomona substation and district office for emergency service in the pumping plants, but pump repairs are handled by other parties. The company pursues a liberal policy in extending short branches of its 10,000-volt circuit, although long taps are not made without assured ample revenue. In a few cases where the installation is large in capacity the Edison company furnishes the transformers, retaining them as a part of its own system. In most cases the transformers are owned by the pumping plants. Distillate engines displaced in pumping plants are sold in the second-hand machinery market, usually outside the Pomona district. The present cost of distillate is about 7 cents per gallon. The rates for electric pumping in general vary from 3 cents to 2 cents per kw-hour, according to the size of plant and guaranteed consumption. The company has begun to install two-rate meters in a small way, a slightly lower price being given for energy consumption between the hours of 11 p. m. and 5 a. m. A typical load curve of the Pomona substation is shown for a day in the height of the irrigation season. The load factor of the substation as a whole was 48 per cent and that of the irrigation pumping service 45 per cent. The peak load was about 2150 kw, and it occurred about 5 p. m., the lighting peak reaching only 1150 kw.

In connection with the introduction of electric pumping in the districts served by the Edison company a 48-page booklet has lately been printed for distribution to interested parties. This contains many valuable comments upon the value of electric service, and among the points emphasized are the durability of motors compared with gasoline and distillate engines, the lower cost of motors, impurities contained in distillate which cut the cylinders and pistons, lack of vibration of motors, shortage of oil supply at times, expert requirements in engine repairs, value of time lost in irrigation through failures of engines, need of skilled and expensive attendance in engine plants, and value of continuous service to the rancher in relation to diversified crop growing. One prominent rancher testifies that twice as much ground can be irrigated by electricity in his 25-hp installation as was possible with his former gasoline engine plant, the ranch occupying about 100 acres. He points out that a close record has always been kept of repair bills, cost of fuel, etc., and that the resulting economy of the electric drive has been very apparent. With the gasoline the repair bills were incessant, troublesome and time-consuming, but "these have now ceased, and there are no more greasy clothes and numerous tinkering jobs to bear with, and the cost of power has never exceeded our gasoline bill with the gas engine; * * * therefore crops that could not have been taken with the old gasoline pumping may now be safely planted, for we have tried it and know." (From Mr. George Eells, Santa Ana, Cal.)

The Del Monte Irrigation Company, Pomona, reports that its water is scheduled to run from the opening of the irrigation season to its close with no provision for interrupted service, and emphasizes the value of electric power to irrigators in maintaining the schedule, which would be disarranged for the rest of the season in case of an interruption. Other testimonials include reports of plants run by electricity for from one to five years with merely nominal repair bills, and the district contains a similar electric plant, which has been in service for ten years with only trifling expenditures for maintenance. As in other parts of the West, electricity applied to irrigation pumping has been the means of enhancng the value of land several hundred per cent, soil formerly worth about $100 per acre now being valued at $500 or upward in many instances. The business is most attractive from the central-station viewpoint on account of its magnitude and continuity during the season when the absence of a lighting peak releases considerable generating capacity for service.

ADJUSTABLE-SPEED MOTORS.—III.

The Principles, Types and Characteristics of Direct-Current Motors for Industrial Service.

BY ALEXANDER DAWES DUBOIS.

THE first instalments of this article, which appeared in the issues of May 18 and May 25, contained a brief treatment of the fundamental principles involved in variation of motor speed and also various methods of speed control. Other methods are described in the following and also combinations and comparisons between the various methods.

CHANGING RELUCTANCE OF MAGNETIC CIRCUIT.

The flux of the magnetic circuit may be varied without changing the mmf by varying the reluctance of the magnetic path. Since it is impossible to change the permeability of any magnetic material the reluctance can be changed only by mechanical movement of the iron parts, so as to change the length of area or the air portions of the circuit.

In one of the early methods, due to Edison, this result was produced by means of a wedge of iron which could be withdrawn to decrease the amount of metal in the yoke, thus reducing the total flux.

Another scheme, the Diehl variable-reluctance method, comprised a hinged yoke, so constructed that the two pole

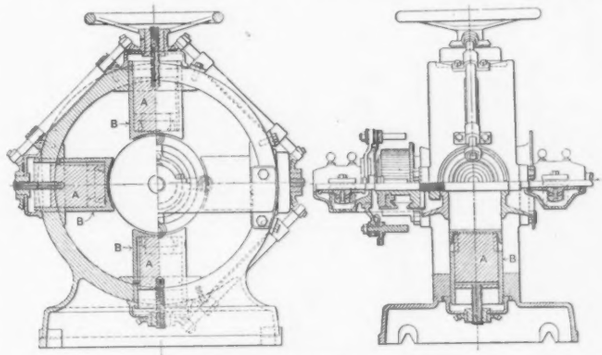


Fig. 23—Stow Multi-Speed Motor.

pieces of a bipolar machine could be closed in upon the armature or opened away from it like a pair of calipers. The air-gap between the armature and the poles was thus varied. These schemes were originally intended for generators, but they do not seem to have been successful in any large degree.

Moving Poles Radially (the Stow multi-speed motor)[1].—The Stow motor is dependent for speed variation upon one of the methods of varying the reluctance of the magnetic circuit. Both the field current and the emf impressed upon the armature are maintained at a constant value, the armature and field windings being directly connected to the line during the operation of the motor. The method of varying the field magnetism is by mechanically moving the pole cores radially with reference to the armature. Each pole piece consists of two parts, a solid cylindrical core or "plunger" *A* and a cylindrical shell *B*, surrounding the core as shown in Fig. 23. The pole shoe is an integral part of the hollow shell *B* and the gap between this shoe and the armature is unchangeable, the shell being rigidly connected with the motor frame. The solid core *A* is free to slide within the outer shell, thus varying the reluctance of the magnetic circuit. When the core is in contact with the shoe end of the shell the magnetic circuit has its minimum reluctance and under this condition the motor runs at its lowest speed. As the core is gradually withdrawn the speed increases, due to the weakening of the field. In some of the larger

[1] U. S. patents Nos. 666,315 and 672,419, January and April, 1901.

motors the pole plunger extends entirely through the pole piece so that its inner end forms a part of the polar surface.

The design of the pole piece and its plunger is such that, as the total magnetic flux is diminished by the outward movement of the plunger, the remaining flux is forced more and more through the pole tips, thus tending to maintain at all speeds a commutating field of sufficient intensity to insure sparkless commutation. It will be observed that as the plunger is being withdrawn the air column within the pole piece offers a gradually increasing barrier to the cross-magnetizing effect of the armature current and when the field strength is reduced to minimum by the reluctance of the air column the armature reaction is also reduced to a minimum through the same cause.

A hand wheel on the top or side of the motor frame is arranged to move the pole cores in or out by means of screws rigidly attached to the pole cores and passing through threaded gear wheels. All the poles are moved simultaneously by the one hand wheel. Because of the nature of the control it is plain that there are no distinct "steps" in the speed variation and it is possible to obtain any speed desired within the limits of the motor. This refinement of speed adjustment is perhaps the most unique operating feature of the design. The total elimination of any electrical controlling device, other than an ordinary starter, is a noteworthy feature though one not adapted to remote control. The standard speed range of these motors is 3 to 1, or a maximum increase of 200 per cent.

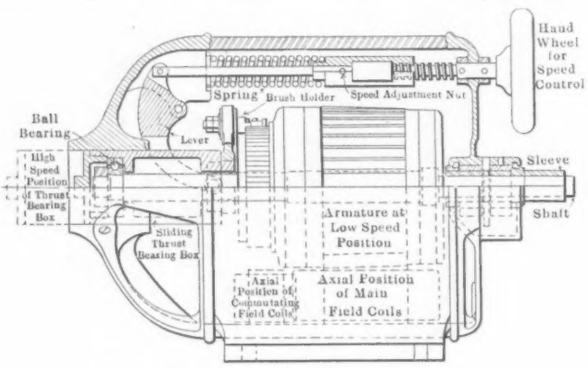


Fig. 24—Lincoln Adjustable-Speed Motor.

Moving the Armature Longitudinally (the Lincoln adjustable-speed motor[1]).—The Lincoln motor is dependent upon variation of reluctance of the magnetic circuit for speed control. The general construction of this motor is shown in the vertical longitudinal section, Fig. 24. The armature is moved in and out longitudinally between the pole pieces. As the armature is withdrawn the area covered by the poles is decreased, and in addition to this the armature is slightly tapered so that the length of air-gap is increased simultaneously with its decrease of area. Thus the variation of length of gap is combined with the variation of magnetic area to produce the desired change of flux. Although the increase in length of air-gap has a tendency to "stiffen" the magnetic field, this feature is not relied upon to prevent sparking at the high speeds. Small commutating poles are provided in such positions that the armature is brought gradually under their influence as it is shifted away from the main poles. The windings of the commutating coils are connected in series with the armature for the reasons explained under interpole motors.

The method of mechanically shifting the position of the armature is clearly shown in Fig. 24. The armature shaft runs in two bearing sleeves; the one at the commutator end of the motor is free to slide axially, but is restrained from turning in the yoke or bearing bracket. In this sleeve is mounted a ball bearing which receives the entire end thrust caused by the displacement of the armature in the magnetic field, as well as the radial load on that end of the shaft. This thrust-bearing box, carrying with it the armature and the brush rigging, is moved in and out by turning the hand wheel at the rear end of the motor. The threaded shaft of the hand wheel turns in an adjustment nut and thus operates a lever to shift the bearing box. In order to reduce the effort necessary to turn the hand wheel a helical spring is provided to balance the end thrust of the armature due to its magnetic pull.

These motors are built for speed ranges as high as 10 to 1 and for reversible operation under all conditions. In this, as in the Stow design, the principle of control renders an infinite number of speed steps available within a given speed range and no electrical controller other than an ordinary starter is required.

[1]U. S. patent No. 829,974, September, 1906.

SHUNTING PART OF FIELD CURRENT.

This is another method by which the field flux may be varied, but it is not adapted to shunt motors, the same result being attained more economically by resistance in series with the field windings. The method is, however, of considerable importance for weakening the fields of series motors and for cutting out the series field coils of compound motors after they have been brought to speed. The latter application is quite extensively used for the control of motors operating passenger elevators. The heavy torque requirement at starting is met by the compound winding and the constant-speed requirement when running at full speed is realized by short-circuiting the series field coils.

CHANGING NUMBER OF ACTIVE ARMATURE CONDUCTORS.

Since the speed of a motor must be such that its rate of cutting flux is just sufficient to generate the impressed voltage (minus the *IR* drop in armature), and since this total rate of cutting depends upon the number of armature conductors in series, as well as upon their velocity, it becomes apparent that changing the number of active conductors will cause a change in speed.

There are two possibilities for making this change while the motor is in operation; first, by using an armature having two or more windings each connected to a separate commutator, and, second, by changing the number of field poles (without changing the total flux), at the same time changing the number of conductors in series by disconnecting certain of the commutator brushes.

SERIES-PARALLEL CONTROL.

Double-Commutator Motors.—In order to vary the number of armature conductors, which add their counter emfs in series between the motor terminals, it is common practice to use two separate armature windings in the same slots and a commutator at each end of the armature. The motor has one field frame and one field winding which may be either shunt or compound as in machines of ordinary design.

The two armature windings may be identical, or they may have a different number of turns. If they are alike (as in the C. & C. and General Electric Company systems[1]) they are run in series for low speed and in parallel for high speed. Such a "series-parallel" control gives two fundamental speeds on a single-voltage system without the use of a resistor in either armature or field circuit. The speed for one winding alone, or for both in parallel, will be twice the speed obtained when the two windings are in series.

If the two armature windings are unlike (as in the Commercial Electric Company system) they are run in series for the lowest speed, and two higher speeds are obtained by running each winding singly, while a fourth still higher speed is sometimes secured by electrically opposing the two windings in series. By this method three or four fundamental speeds are available.

For either of these two classes only one line voltage is necessary. The intervening speed steps between those

[1]U. S. patent No. 757,394, April, 1904.

obtained by the change of armature conductors are usually secured by shunt-field control. A resistor in the armature circuit may be used in some cases. The total speed range is commonly 4 to 1, with the speed steps arranged in geometrical progression.

C. & C. Electric Company System.—The C. & C. series-parallel system has been used principally for the operation of large printing presses, though also adapted for driving other kinds of machinery.

The motor for printing-press service is of the ordinary low-speed, compound type, with the exception that it has two commutators and two separate armature windings on the one armature core. The two armature windings are exactly alike so that they may be run in parallel, and the speed adjustment is obtained by running them first in series and then in parallel; they are not run separately. The field windings are so arranged that the series-field coils can be cut out after starting, thus securing the advantages of a powerful torque with minimum current at starting and the good regulation of a shunt motor when running.

Resistance is inserted in the armature circuit for all speeds between the two primary speeds and for speeds below that obtained by the series connection of the armature windings. Shunt-field current control is used for the speeds above those of the parallel connection of the two armature windings.

The controller, though somewhat elaborate, is operated by one lever. When the armature connections are changed over from series to parallel or vice versa it is necessary to open the circuit and an automatic solenoid switch of special design serves to make this change without the use of blow-out coils.

Commercial Electric Company System.—The system introduced by this company is of the second named class of double-commutator motors—that is, those having two dissimilar armature windings which may be connected separately or in series, but are never run in parallel. The number of turns in the two windings is in the proportion of 2 to 3. If the number of turns in one winding be denoted by $2X$ and the number in the other winding by $3X$, it becomes apparent that the following relative speeds are obtainable:

Two windings in series, opposed; X conductors effective; speed = maximum.

The $2X$ winding alone; $2X$ conductors effective; speed = one-half maximum.

The $3X$ winding alone; $3X$ conductors effective; speed = one-third maximum.

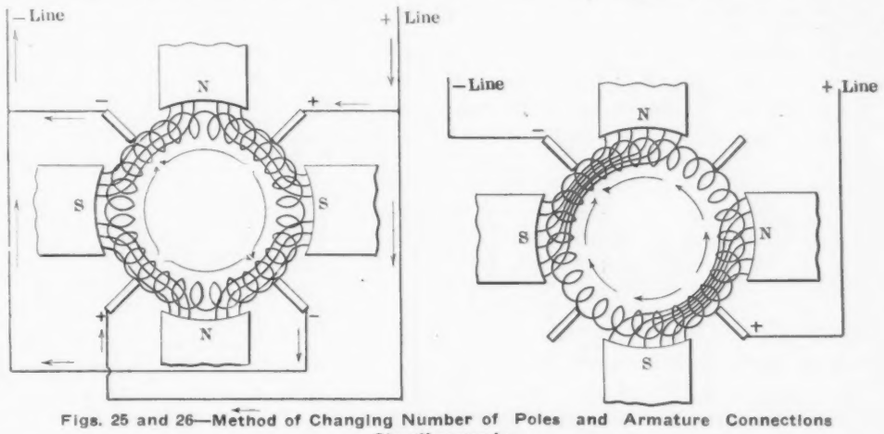
Two windings in series, $5X$ conductors effective; speed = one-fifth maximum.

Thus if the minimum speed be represented as 1, the other speeds will be 1.7, 2.5 and 5.0. For the intermediate speeds field-current regulation is the method employed. By omitting the opposition or maximum speed connections it is still possible to produce a four-to-one speed range, using about 40 per cent field control for the intermediate steps and 60 per cent above the highest fundamental speed. With this arrangement the total range is divided into twelve steps in the controller.

James Clark, Jr., & Company's Motors.—A double-commutator motor for machine-tool and similar variable-speed service has been introduced by James Clark, Jr., & Company. The two windings on the armature are in proportion of about three to five. For the lowest speed these windings are run in series and two higher speeds are obtained by running them singly. The intervening speeds are obtained by means of resistance in the shunt-field circuit. The controllers are usually constructed to give fifteen speeds in approximately geometrical progression. The inherent speed regulation on varying loads is good and the full-load efficiency does not vary much at different speeds within the range, as the separate windings are designed for the voltages used.

The standard speed range of these motors is four to one. If the two windings in series give a speed of one the long winding along will give 1.6 and the short winding alone 2.66. From 2.66 to 4 is an increase of 50 per cent, which is obtainable by field-current control. It is seen that the same or a slightly greater field range between the primary speeds makes possible a practically uniform variation of speed from minimum to maximum.

In cases where two or more voltages are not warranted and a wide range of speed is necessary, especially where the load is of a nature tending toward constant torque rather than constant power, a double-commutator motor may be used with excellent results. When the series-parallel control is used the speed changes correspond to those of the three-wire equal-voltage system. The double-commutator motors have very good inherent speed regulation—that is, the speed is nearly constant at all loads. The advantages of operation on a single-voltage two-wire system have been pointed out. The two commutators, because of first cost and the extra maintenance they involve, are rather serious objections.



Figs. 25 and 26—Method of Changing Number of Poles and Armature Connections Simultaneously.

CHANGING NUMBER OF POLES.

Although this method has not met with commercial success, it is worthy of mention as illustrating a possibility which has been subjected to test. A system was at one time developed by the Bullock company in which the number of poles and the armature connections were simultaneously changed in such a manner as to change the number of armature conductors in series between terminals without changing the total flux to be cut by these conductors. The change of connections by which this was accomplished with one commutator is indicated in Figs. 25 and 26, which show a four-pole frame with ring-wound armature. In Fig. 25 the connections are normal; alternate brushes are connected to the same terminal and the current in the armature takes the four paths indicated by the arrows. If there are n conductors on the armature the number in series between terminals is $n \div 4$.

Fig. 26 shows two of the field poles reversed in polarity and two of the brushes disconnected from the circuit, while the other two brushes, which were formerly both negative terminals, have now been connected to the line as positive and negative terminals respectively. The result is a two-pole motor having approximately the same total flux as

before, but with only two paths for current through the armature and consequently $n \div 2$ conductors in series between terminals. Since there are twice as many conductors in series, the speed is reduced to one-half, with the same total field and the same terminal voltage.

By the same means an eight-pole machine could be changed to a four-pole and a two-pole; a twelve-pole machine could be changed to a six-pole and a two-pole, the speed obtained in each case being directly proportional to the number of effective poles.

The armatures of these machines were necessarily of the Gramme ring type, which was expensive to wind and uneconomical of copper. A larger field frame was required to provide sufficient cross-section for the two-pole distribution of flux and a somewhat complex switching device was necessary to make the change of connections. The regulation was very poor on low speeds and the motor lost its torque and thus gave trouble when the poles were changed.

COMBINATION METHODS.

In some of the systems previously described the complete speed range is in reality obtained by supplementing the principal method by a secondary one, as, for example, the multi-voltage systems which usually combine armature and field control. In such cases, however, it is evident which is the basic method and the systems have been classified accordingly.

In several industries specialized equipments have been developed to meet peculiar requirements of drive or automatic control. These systems do not involve new *electrical* combinations of the basic methods, but are specialized in their mechanical applications and in the controlling equipments. The two-motor drives for printing presses and the special steel-mill drives are examples. They will not be described here.

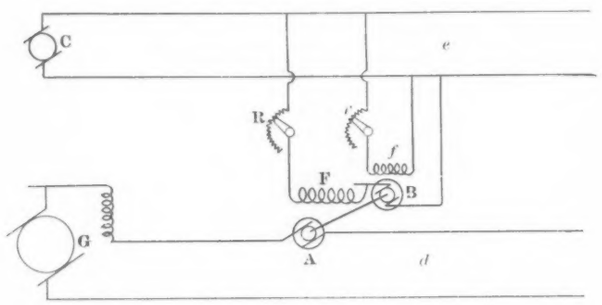


Fig. 27—Connections for Dunn Method of Indirect Control.

In the following system the two methods of armature and field control are so involved as to preclude classification under either of these heads.

Dunn Method of "Indirect Control."[1]—This unique scheme, proposed by Mr. Gano Dunn, consists essentially in connecting the armatures of all the working motors in series in a constant-current circuit which is entirely independent of the field circuits. The field coils are supplied with energy from a separate constant-potential circuit. In order that the speed may be constant under varying load a small "regulating generator," *B*, is belted to the working motor *A*, Fig. 27, and the generator armature is connected as a reversed booster in the field circuit of the working motor. The performance of such a system is very unusual. The armature voltage varies automatically with the load and the torque varies directly as the field strength at all times; hence the motor gives maximum speed and maximum torque with maximum strength of field.

If the torque of the load be increased the motor is called upon for increased torque, but it cannot automatically develop it because its torque is fixed by the constant armature current and the particular field strength for which its field rheostat is at the time adjusted. Since it cannot develop more torque by any change of speed the motor must be stalled under such conditions unless the field strength be increased to such a point as to produce the new torque. This is accomplished automatically by the small auxiliary generator or regulating machine *B*. When the motor slows down this generator slows down also, its emf is thus reduced and (since it is connected in opposition in the field circuit) the motor field is strengthened. The torque of the motor is thereby automatically adjusted to the required value to drive the load at the required speed. Should the speed exceed the value for which the apparatus is adjusted the reverse operation is automatically performed, the torque of the motor being reduced by the weakened field to just that value required by the load.

To increase the speed of the motor the field is strengthened by decreasing the resistance in the rheostat *R*, or to decrease the speed the field is weakened by the same rheostat. For example, assume the motor to be operating a constant-torque load at a given speed and that it is desired to double that speed. The motor field being strengthened slightly by the attendant, the motor will accelerate because it is developing more torque than the load requires and the additional torque is available for acceleration. The acceleration will continue until arrested by the regulating machine *B* at the speed for which the adjustments are made, as previously explained. Assuming that the speed has been doubled, the power output is also doubled. The armature current cannot change, but the voltage (counter emf) is doubled, due to the increased speed. It is apparent that the field strength in such a case is varied only enough to provide the additional *accelerating* torque while the motor is speeding up, since the load torque was assumed to remain unchanged.

The speed then is dependent upon the field strength only in so far as the different speeds involve different torque (due to windage, etc.), but any speed within certain limits may be obtained by so changing the torque developed as to produce an acceleration or permit a retardation to the desired speed and then adjusting the torque to the torque of the load, which adjustment is automatically maintained by the regulating machine. The motor may be reversed by reversing its field-circuit terminals.

This system should give any torque at any speed from zero to the limit of its output. It involves two distributing or supply systems, one of which must be served by a constant-current generator, and if several motors are in series a high voltage is necessary.

COMPARISON OF ADJUSTABLE-SPEED SYSTEMS.

Speed Torque.—In the interest of the best performance of an adjustable-speed motor its torque-speed characteristics should agree as nearly as possible with the characteristics of the load which it is to drive. The characteristics of adjustable-speed motors as influenced by different systems of control should, therefore, be carefully examined. These general relationships are summarized in Table VI for the three fundamental methods of speed variation, including two schemes of winding for the method of changing the number of armature conductors in series from brush to brush.

This summary shows the following facts:

1. Speed control by changing the emf impressed on the armature gives constant torque at all speeds, and the power varies directly with the speed.

2. Speed control by changing the field flux gives constant power at all speeds and a torque varying inversely as the speed.

3. Speed control by changing the conductors in series from brush to brush (by means of two armature windings) gives characteristics which depend upon the particular arrangement used. The torque may be constant if the two armature windings are identical, or it may decrease some-

[1] U. S. patents No. 549,061, Oct. 29, 1895, and No. 591,345, Oct. 5, 1897.

what as the speed increases, though at a rate less than inverse ratio if the armature windings are unequal. The power varies directly with the speed in the first case and in the same sense, though at a less rate, in the second case.

4. By no one of these methods alone is it possible to make the torque of the motor increase with an increase of speed.

5. Armature voltage and field-current control are inherently different in their torque-speed characteristics and should not be compared on the same basis.

Inherent regulation, which is another characteristic of importance, may be summed up in a general way as follows:

Emf method, regulation variable—poor on low voltages.
Flux method, regulation good at all speeds.
Conductor method, regulation good at all speeds.

Size of Motors.—It has been broadly stated by several writers that a motor of standard design to give constant output through a speed range of two to one by field flux

TABLE VI.—COMPARISON OF TORQUE-SPEED CHARACTERISTICS OF GENERAL METHODS OF VARYING SPEEDS.

Method of Control.		Condition.	Speed.	Torque.	HORSE-POWER.	
					Expressed as Torque Times Speed.	Expressed as Per Cent of Maximum.
E	Changing volts impressed, E.	E=1.	1	1	1	25
		E=2.	2	1	2	50
		E=4.	4	1	4	100
ϕ	Changing flux, ϕ.	ϕ=4.	1	4	4	100
		ϕ=2.	2	2	4	100
		ϕ=1.	4	1	4	100
Y	Changing conductors. Series-parallel. Windings identical.	Windings series	1	1	1	50
		Windings parallel	2	1	2	100
	Changing conductors: series, then singly. Windings in ratio 3:5. (Assumes windings same cross-section for simplicity.)	Windings series	1	1.63	1.63	61.3
		Five-turn winding alone	1.6	1.28	2.05	77
		Three-turn winding alone	2.66	1	2.66	100.0

control must be four times as large as a fixed-speed motor of the same output, whereas by armature-voltage control it need be only twice as large as would be required for the same output at the maximum speed. The deduction thus reached is that the size of motor required varies directly as the speed range by armature-voltage control, but as the square of the speed range by field-current control, so that the field-controlled motor must be twice as large as the voltage-controlled machine for a range of two to one and four times as large for a range of four to one.

To illustrate, suppose 5 hp is required throughout a range of 500 r.p.m. to 1000 r.p.m. By armature-voltage control a 10-hp, 1000-r.p.m. motor would have to be used since the output would be reduced to half on half speed. By field-current control one could use a motor designed for a normal speed of 500 r.p.m., but in order to run sparklessly on half field strength it is commonly assumed that the motor must operate at half-load current, which means that it must be normally a 10-hp motor at 500 r.p.m. to be able to deliver 5 hp with weakened field at a speed of 1000. Now a 10-hp, 500-r.p.m. motor would be equal in size to a 20-hp, 1000-r.p.m. motor. Hence a 20-hp unit is said to be necessary with field-current control as compared with a 10-hp unit with armature-voltage control.

These comparisons are based on the assumption that motors designed for constant-speed duty are worked at their sparking limit as well as their heating limit on full field strength. This assumption is not fully warranted. The average motor will withstand a considerable increase of speed by field flux weakening without serious sparking. As an example, a standard 7.5-hp motor at 875 r.p.m. (or 3.5 hp at 400 r.p.m.) which was rated by a certain manufacturer at 3 hp for adjustable-speed machine-tool service from 400 r.p.m. to 1600 r.p.m. was found to operate satisfactorily throughout the range. A motor of almost the same size would have been necessary with armature-voltage control.

In a paper before the Cincinnati Chapter of the American Institute of Electrical Engineers Feb. 9, 1903, Mr. William Cooper described a graphical method for determining the minimum size of motor for any predetermined speed range by combining multiple-voltage and field-current control in such proportions as to work the motor at its heating limit at the lower and at its sparking limit at the upper end of the speed range. Mr. Cooper's curves are based on the assumption discussed above, namely, that the size of the field-current-controlled motor will be proportional to the square of the speed range.

For the requirement of *constant torque* throughout the speed range (the power varying directly as the speed) the matter of comparative sizes has a different aspect. For example, assume the requirement of constant torque through a speed range from 300 r.p.m. to 1200 r.p.m., the power being 5 hp at 300 r.p.m. and 20 hp at 1200 r.p.m. By armature-voltage control the motor would be a standard 20-hp, 1200-r.p.m. machine. With field-current control it would have to be a 20-hp, 300-r.p.m. motor having four times the armature-current rating of the other motor in order to produce the required torque with one-fourth normal field. The field-current-controlled motor would be four times as large as the armature-controlled (20 hp at 300 r.p.m. requires the same size motor as 80 hp at 1200 r.p.m.). This conclusion is based on the assumption of an interpole or other special type of design for taking care of commutation. It is, therefore, plain that field-controlled motors are not suitable for constant-torque loads.

Motors for Machine Tools.—For machine-tool work the requirements are about as follows:

Simple and convenient control; good speed regulation; reversibility; wide speed range, say, four to one; sparkless commutation under overloads; high efficiency at all loads and all speeds; compactness; simple distributing system; simple accessories; moderate first cost.

The majority of machine tools have constant-power characteristics, yet many require constant torque. It is hardly to be expected that any one system would fully meet all possible conditions. The four-wire multiple-voltage system falls short in several particulars. In speed regulation, simple control, efficiency and simple distributing system and accessories it fails to measure up fully to the desired specifications. It is generally recognized, however, that for work where constant torque is required over a wide range of speed the multiple-voltage arrangement has important advantages. Where constant power is the requirement a system of field-flux control is decidedly superior to multiple voltage. A multi-voltage distributing system may have flux-controlled motors connected to its outside wires and will thus provide both methods of control. Single-voltage distribution, while the simplest and least costly system, will serve double-commutator motors as well as those controlled by field weakening and will therefore fairly meet all conditions. Should the conditions indicate a compromise system of universal application yet less costly than multiple voltage, the result will be very well realized by equal-voltage, three-wire distribution.

Central Station
Management, Policies and Commercial Methods

ELECTRICITY IN KANSAS DYE WORKS.

The People's Cleaning & Dye Works, of Wichita, Kan., make use of nearly fifty electric irons and half a dozen motors, consuming from 2500 kw.-hr. to 3000 kw.-hr. each month. In the men's clothes-pressing department fifteen 18-lb. irons are employed, while the rest of the irons are of the 6-lb. and lighter sizes suitable for more delicate fabrics. A 15-hp, three-phase motor drives three centrifugal extractors, five washing machines and one steam-heated tumbler or drier. Another extractor is driven by a 2-hp motor, and a 5-hp motor operates the elevator communicating with the second floor. Mr. J. S. Giwosky, proprietor of the plant, installed his first electric iron five years ago when the business was on a small scale, and its development since has been traced at each step by the increasing connected electrical load. At the present time the cleaning plant guarantees the Kansas Gas & Electric Company $75 monthly as its minimum bill based on connected load.

ELECTRIC VEHICLES FOR CENTRAL STATIONS.

The Louisville Lighting Company, of Louisville, Ky., is planning to install a motor-truck service which is intended ultimately to replace all of the horse-drawn equipment of the company. An electric truck with a load rating of 1.5 tons has been purchased, and several other trucks, varying in load rating from 1000 lb. to 3000 lb., will be added in the immediate future. These will be used for the distribution of meters and for general construction purposes. The company has also under consideration substituting motor trucks for the two-wheel carts which are now used in arc-lamp maintenance. Six of these are in service, and in summer the work is extremely hard on the horses, of which two are needed for each cart. A light, speedy truck would not only be much more economical to maintain, but would also do more efficient work and involve less rapid depreciation, it is believed. At present the idea is to buy four or five trucks, test them thoroughly to determine their capabilities, and gradually increase the number in service until the horse-drawn equipment is entirely displaced. All the trucks will be of the electric type. Mr. P. T. Glidden, general manager of the company, has taken personal charge of the plan.

ST. LOUIS PLANNING FOR MISSISSIPPI HYDRO-ELECTRIC ENERGY.

Taking advantage of the prospect of cheap hydroelectric energy transmitted from the great Mississippi River hydroelectric development at Keokuk, Ia., the Union Electric Light & Power Company, of St. Louis, has issued an interesting booklet entitled "Our Dream Comes True," and referring to St. Louis under the title "A City of Power Without a Peer." It is related that, after years of planning, St. Louis will shortly have electrically transmitted energy from the Mississippi River in a practically unlimited amount. It is intended to make St. Louis one of the great energy markets of the world. The hydroelectric energy will be distinguished from steam-produced electricity by the designation "unrefined." It will be supplied to customers in blocks of 200 kw or over in the form of 13,200-volt, 25-cycle energy. The purchaser must provide or pay for his own transformer installation. Under these conditions the net rate for this energy will be $20 per kw per year for the first 200 kw of demand and $15 per kw demand per year for all excess, plus an energy charge of 0.5 cent per kw-hr. Comprehensive distribution plans have been worked out providing that the "unrefined" energy shall be available in all parts of St. Louis for manufacturing purposes.

Pending the delivery to the St. Louis company of the hydroelectric energy, for the Keokuk plant is still under construction, the company offers to enter into contracts at the wholesale high-potential rate mentioned, delivering the energy in the meantime from its Ashley Street generating plant. When completed the Keokuk plant will have a rating of 100,000 kw or over, and ultimately 60,000 kw of this or more will be transmitted to St. Louis, a distance of about 160 miles.

CENTRAL-STATION ORDER TRANSMITTER AND RECORDER.

As a means of establishing closer and more speedy communication and co-operation between the system operator and the operators in its various substations, the New York Edison Company recently installed a very comprehensive and complete signaling system, the equipment consisting of Gamewell fire-alarm apparatus, using for the circuits the leased lines of the New York Telephone Company. As is well known, this type of equipment provides for the transmission of signals through a numerical code similar to that in use for fire-alarm purposes. The master sending device is located in the system operator's office at the Waterside station. Any signal, from 1 to 999, may be sent, the

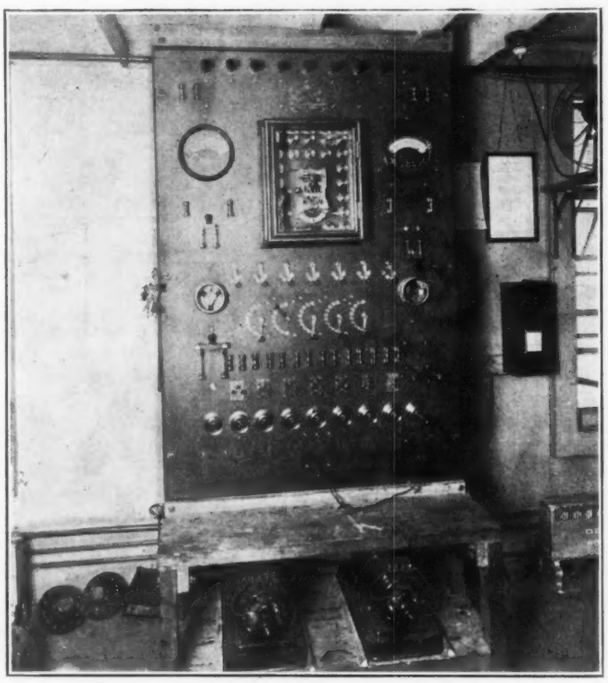


Fig. 1—Switchboard Equipment for Signaling System.

impulses being given to the make-and-break contacts by means of a brass wheel with the requisite number of notches cut into its circumference, a separate wheel being provided for each signal number, and by adjusting a lever attached to the transmitter any signal may be repeated from two to four times. Under the present arrangement signals are repeated three times.

The switchboard for this system, which is operated on a closed circuit, is installed in the Waterside station. The supply of energy for the motor-generators, which are installed in duplicate, is taken from the station exciter bus, so that the uninterrupted operation of the system is assured. The switchboard equipment comprises, besides the transmitter, switches for the motors and generators, volt-

Fig. 2—Recording Equipment of Signaling System.

meters and ammeters, testing plugs, balancing resistors for the various circuits and telltale lamps connected to relays, to show at once when any circuit is accidentally opened or the current supply diminished or entirely interrupted. The substations are connected to seven series circuits, each of which has from three to seven local stations in series, and by means of switches any signal may be transmitted to the group of stations connected to an individual circuit or to any combination of the circuits.

The recording equipment at Waterside consists of a multiple punch recorder and automatic time stamp, so that a record is provided of every signal sent over any circuit, with the time that it was sent. The punch type of recorder obviates the difficulties usually experienced with apparatus of the printing type. In the substations the standard equipment consists of a punch recorder and a 10-in. electro-mechanical gong. On account of the high resistance of the telephone circuits, all instruments were specially wound for a normal operating current of 50 milliamperes, a total of 350 milliamperes being required for the seven circuits. The code of signals has been developed so that the decimal groups of numbers have reference to specific instructions.

The operations incident to sending a signal are as follows: The wheel representing the number to be sent is taken from the rack, placed on the shaft of the transmitter and the sending lever pulled, the number of times that the signal is to be repeated having previously been set. The system operator has nothing further to do, knowing that all stations on the circuit over which the alarm has been sent will receive the order.

At present thirty-one substations are connected to the signal system, comprising the district from the Battery to Fordham, and assuming that a half minute be required for a telephone message, at least fifteen minutes would be necessary to give an order to all substations by telephone, whereas with the new apparatus the same order may be given in less than one minute, be recorded on a tape so that there can be no misunderstanding, and only ten seconds of the system operator's time be necessary for his part of the work.

A time signal is sent every day at noon, in order that all substation clocks may agree with the one at Waterside, which in addition gives a daily operating test of the system. The apparatus being electro-mechanical, winding orders are also sent by the system operator, so as to insure against the possibility of apparatus in any station being run down. A set of instruments installed in the executive offices records all signals sent from Waterside, and it is thus possible to keep in touch with all orders issued by the system operator to the various substations.

This system has proved a great time-saver as a means of quick communication with substations, and it greatly facilitates operations such as shifting load from one generating station to another, cutting in or out of storage-battery equipment, etc.

In a recent test of this signaling system, where an order was given to a district consisting of seven substations to drop load from one of the generating stations and to pick it up on storage batteries, 10,000 kw was transferred in one minute after the signal was received. This would be impossible in such a short space of time if the carrying out of the order depended on telephone communication. Emphasis is given to the important point that all orders are carried out simultaneously in the district affected.

The installation of the above-described signaling apparatus came as the result of a great deal of consideration and planning covering a period of several years, during which time the need for a very rapid and dependable means of communication manifested itself. The special benefits to be derived from the simultaneous and concerted co-operation of all stations, together with the resulting freedom afforded the system operator for action in other directions, cannot be overestimated. All of which should serve as "added ammunition" in the fight to maintain a high standard of service.

POWER-PLANT EFFICIENCY AS DETERMINED BY THE TECHNICAL EDUCATION OF EMPLOYEES.

By C. M. Jansky.

The idea that profits are determined by the ignorance of employees is still the principle of action of some prominent managers of public utilities. To learn if there is even an element of truth in the assumed principle that ignorance on the part of the employees increases profits, the writer made a brief and incomplete investigation with reference to some of the smaller central electric stations of the State of Wisconsin.

Many investigations have been made concerning the relative incomes of technically trained or college men and so-called practical men, men who have never attended a technical school. The results of these investigations show that the income of the technically trained man for the first few years of his employment after graduation is less than the average of the practical man. Curves have been drawn showing that between the ages of twenty-five and thirty the technical man's income becomes higher. The practical man's income curve reaches a maximum value above which it does not rise, while the income curve of the technically trained man does not have a maximum value, but increases during the active life of the man.

These facts supply some of the favorite arguments of engineering college authorities in regard to the value of technical education. While arguments based on these facts are valid and legitimate, they nevertheless do not tell the whole story. In the main the work performed by the col-

lege graduate is different from that performed by the man who has not had the advantages of a college education. The purpose of the present investigation was to look at the other side of the question, to find out, if possible, if the employers' income and profit increase in proportion to the number of technically trained men or in proportion to the quality of the training. That is, does the employment of technically trained men in fields usually occupied by untrained and unskilled labor increase the efficiency of the plant?

The writer is well aware of many defects in such an investigation and knows that many objections can be urged against any conclusion that may be drawn from data from plants that operate under different conditions, have different machinery, different load-factors and many other differences that might be mentioned. Not knowing what the data would be, but believing that some interesting, if not valuable, information might be obtained, 100 information blanks were sent out to as many superintendents and managers of lighting plants in different parts of the State. The information asked for had reference to the number of men employed in various positions, the character of their education and the number of years' practical experience. Replies were received from about fifty plants. The fifty reports were classified in accordance with the population of the towns as follows:

Group.	Population of Towns.	Number of Reports.	Total Employees.	Remarks.
A	1,500 to 2,000	10	27	
B	2,000 to 2,500	9	26	
C	2,500 to 3,000	3	11	
D	3,000 to 3,500	6	29	
E	3,500 to 4,000	2	10	
F	4,500 to 5,000	3	7	Reports incomplete.
G	5,000 to 5,500	4	18	
H	5,500 to 6,000	2	...	One water-power; other incomplete.
I	6,000 to 7,000	2	7	One water-power; 1 steam.
J	12,000 to 20,000	5	27	One water-power; 3 steam; incomplete.
K	24,000 to 37,000	4	36	Three steam; 1 water-power
		50	198	

Summarizing the reports as to the educational qualifications, we get the following:

One superintendent or manager in each of the groups A, I and K is reported to be a graduate of the literary department of some college or university. One plant in each of the groups B, D, E and G is managed by a technical college graduate. This makes seven superintendents in all who have had college training, four of whom are graduates of engineering schools.

None of the stationary engineers has had the advantages of a college training, either literary or technical. The boiler room of one plant is presided over by a man who has had two years' college training; this is in group B. In group G we find one technical graduate as station electrician.

The meters of three stations are kept in good running order by college-trained men, one man in each group, A, D and E respectively. Out of a total of four men, one plant in group E reports two with college training, a superintendent and a meterman.

The total number of men employed according to the reports is about 200, while the total number of those who have had a college education, either technical or literary, is thirteen. Six of these have specially prepared for the work in which they are now employed.

A further analysis of the reports discloses the fact that, although only six men have made special college preparation for their work, others appreciate the necessity of such preparation. This is especially true of the superintendents and managers, for sixteen of them have pursued technical courses by correspondence. They also report five engineers, one boiler-room employee and nine electricians as also having made some preparation by correspondence instruction. Since the extent of this training is not disclosed by the reports, no conclusion can be drawn therefrom. The remaining 154 employees are reported as having had no technical training, their educational advantages ranging from that furnished by a good high school to "pick ups," as one superintendent expressed it.

Although other interesting information was disclosed by the reports, such as the attitude of the superintendent or manager toward his men and toward the subject in general, no further analysis was attempted for reasons presently disclosed.

In beginning the investigation the writer hoped to get from the statistical department of the Railroad Commission data concerning the efficiencies of the various plants, and by combining the two sets of data he thought that perhaps some relation between the technical training of the employees and the efficiency of the plant might be disclosed. It was soon found, however, that a mistake had been made in the title of this paper; the word "employees" should be "employers."

Even a cursory examination of some twenty reports shows that some of the smaller plants of the State are run in accordance neither with technical nor good business principles. The facts disclosed by the reports examined are such that no definite conclusions can be made concerning the relation between the technical training of the employees and the efficiency of the plant. The characteristics of some of these reports are as follows:

One plant reports that the superintendent was "fired" last July and that he left no records. A statement of estimated receipts and expenditures is given, which shows that the plant is losing $1,800 annually. This being a municipal plant, no account is taken of the cost of operating the street lights.

A privately owned plant does not see the necessity of keeping an account of its fuel bill and reports an annual coal consumption of *about* 604,000 lb. Of course, the use of the word *about* could be overlooked if the rest of the report showed that any record was kept of the output and other necessary items.

Another municipal plant has no record of the total energy output, but reports as sold 1,036,200 kw-hours of energy. This output is the product of one 162-kw generator. If these figures are accurate the plant must be operating under a load-factor exceeded by only one other plant in the State, which reports an output of 5,326,923 kw-hours from one 250-kw generator.

Still another municipal plant, after repeated requests, sends in a report which is not even disfigured by inaccurate data. The superintendent of this plant reported that his engineers were mere "dubs," and that he acquired his education mainly by "pick-ups." Judging from the statistical report, one is inclined to say that the "pickings" were poor.

A private plant that does an annual business of $55,200 had to be vigorously stimulated before any report could be obtained. The report as finally sent in shows no record of the output.

The manager of another private plant, whose report was corrected by the statistician after several unavailing attempts on the part of the manager, thanks the statistician for his patience and expresses the sincere hope that he may receive his reward in the future world if not in this.

Out of a total of twenty-one records examined, thirteen may be considered as poor and incomplete; one may be called fair, five good and two excellent. These reports are from plants differing greatly in size, so it would be unfair to compare their efficiencies.

It may, however, be of interest to compare the data of two plants operating in towns of nearly the same size, one in group D and the other in group E.

Plant D has an annual operating revenue of $22,800 (in round numbers) and operating expenses of $21,600, leaving a net operating revenue of $1,200. The total output of the plant is given as 240,807 kw-hours and a total coal consumption of 3,377,097 lb., or 14.02 lb. of coal for every switchboard kw-hour.

The report of plant E is more accurate and more complete. It reports an operating revenue of $10,500; total operating expenses $8,500, leaving a net operating revenue of $2,000. The total output of the plant is 112,123 kw-hours, with a fuel consumption of 923,000 lb., or one switchboard kw-hour for 8.23 lb. of coal.

Plant D pays $3.50 per ton and plant E $3,66 for the coal used.

Although the towns in which the plants operate are practically the same in size, there are undoubtedly local conditions favorable to the one and unfavorable to the other. Yet it does not seem possible that purely local conditions could be responsible for a difference of 5.49 lb. of coal per kw-hour output in favor of the plant doing the smaller business. The conclusion seems inevitable that the technical training of the operators may have something to do with this great discrepancy. Plant D reports no employee with any technical training, while plant E reports two college men in its employ. The superintendent of plant E is a technical man, having received his training at one of the best technical schools in the country. The meterman is also a college graduate, but the report does not state whether his training has been technical or literary.

If doubt is cast on the validity of this conclusion, the only reply that can be made is that more weighty conclusions are daily being made from weaker premises.

If the above conclusion is correct, plant D would be justified in paying a good technical man some $2,000 a year and thereby reducing its operating expenses. The amount saved in the coal bill alone would pay this and leave a balance in favor of the company. What other savings might be made a thorough examination of the plant alone would disclose.

The lesson of all this is that the time has gone by when any business or industrial organization can be run by "rule of thumb," and that the purely practical man instead of speaking disparagingly of the theories of the technical man will have to seek the technical man's advice more and more.

The popular question of the day is the subject of "conservation of natural resources." The place to begin to conserve resources is where they are needlessly wasted. The waste in the small plants is in the aggregate a very important item.

To be efficient, that is to be practical, in the management of any industrial establishment, the superintendent must be qualified by training and experience to conduct the work in conformity with engineering principles. Unless he knows and takes advantage of the fundamental scientific principles that apply in that industry, he must of necessity waste energy, time and money.

In the operation of nearly all industrial works it is necessary to meet intelligent competition, and if competition is absent economic and efficient production must be the aim. This means that the superintendent or manager must be constantly on the lookout for improved and more economical methods of production. How can this be done if he concerns himself only with the result as to the product and keeps no record of the work step by step; or, worse yet, if he keeps no records at all and estimates the cost? This leads to the subject of accounting, which, however, is not the subject of discussion. The important point is that any method of accounting is valueless or worse than valueless in so far as efficient production is concerned unless the manager and employees have had sufficient technical training to understand the relation and interdependence of the various physical quantities involved. It is one thing to deal with figures alone and, when there is a deficit, lower the wages of the employees until there is a proper showing in the ledger; it is entirely another thing to know all the physical principles and their relations to one another so that the cause of inefficient production can be scientifically remedied. At first it is not a money leak that confronts the manager, but an improper adjustment of physical quantities. No amount of bookkeeping or accounting will disclose to him the excessive losses in his transmission line, the low efficiency of his engines, the inaccuracies of his meters, the proper relation of pounds of coal to switchboard kw-hours, or any of the physical relations that go toward an economical production and distribution of the energy, unless he possesses a sufficient amount of scientific knowledge to interpret the facts properly. When the superintendent lacks this fundamental knowledge of scientific principles the figures in his books disclose to him little more than a book of logarithms does to a man who does not understand their use.

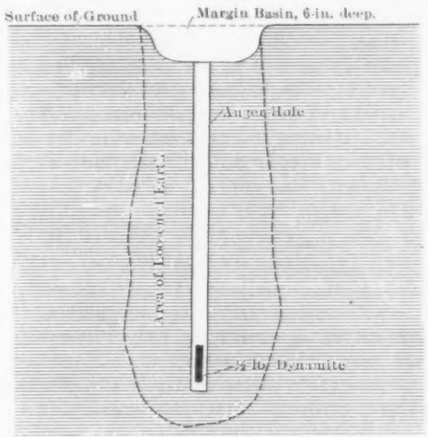
The conclusion seems inevitable that to have effective conservation of our natural energy resources the technical training of many managers and employers in power plants will have to be more thorough and accurate than it is at present.

Wiring and Illumination

DIGGING POLE HOLES WITH DYNAMITE.

Experiments made by the Marion (Ind.) central-station company with the use of dynamite for opening pole holes in frozen ground indicate that the explosive reduces the excavation cost from $1.75 to about 35 cents per pole, besides enabling one gang to dig sixteen to eighteen holes —about a mile of line—a day.

In preparing for the dynamite a little basin 6 in. deep and the size of the hole is first opened at the surface of the ground to prevent the explosive action from spreading. Then with an auger a 2-in. hole is bored to the desired depth of the excavation, and into this hole is dropped a half-pound stick of dynamite, about 16 cents' worth. The resulting explosion shatters the ground about the auger hole, loosening the frozen earth at the surface up to the margin of the basin first cut. This loosened earth in the hole can then be "spooned" out as easily as any uncompacted material and the hole is ready for the pole. In



Digging Pole Holes with Dynamite.

making preliminary tests in frozen ground at Marion it was necessary to set off two half-pound charges at different depths for each pole, but with unfrozen ground only one 16-cent charge is likely to be required. Further tests are now being made at Marion on excavating with dynamite, and these will be reported later. This labor-saving application of the explosive seems to be a new one.

A NEW FORM OF CANDLES-PER-WATT METER FOR INCANDESCENT ELECTRIC LAMPS.

By Herbert E. Ives.

Incandescent electric lamps are now rated, in this country at least, on the basis of specific output. Where formerly lamps were designated by candle-power and voltage they are now marked according to wattage and voltage, with the understanding that at the rated voltage they are of a definite efficiency. Uniform specific output (or candles per watt) means uniform operating temperature, color and life, factors now considered of greater importance than uniform candle-power, especially if the latter is purchased at the cost of irregular life performance.

The increasing stress laid upon specific-output rating has made it important to have available instruments for measuring candles per watt and—particularly important from the manufacturer's standpoint—instruments for indicating the voltage at which a lamp reaches the desired standard. The instrument here described is designed to meet both these requirements.

A parallel description of the candle-power photometer as formerly used and of an ideal specific-output meter will assist in making clear the requirements for the latter instrument. The candle-power photometer, as used in factories and testing laboratories, can be employed in the three following ways:

1. As an instrument for measuring the candle-power of a lamp at a given voltage. In general this is indicated by the position of the photometer head when a photometric match obtains.

2. As a volt-scale instrument. In place of a candle-power scale each candle-power mark is replaced by a voltage. With the test lamps operated at a certain voltage each indicated candle-power calls for a definite different voltage in order that the lamp may be at the desired candle-power. A different volt scale is necessary for every operating voltage, and the voltage-candle-power relation is different for each kind of lamp—carbon, tungsten, etc.—and sometimes between different lamps of the same filament composition. In certain factory practice volt-scale instruments are used on what is called single circuit. Both test lamp and standard lamp are on the same voltage supply, and if the lamps are of similar type fluctuations of voltage affect each approximately alike and are consequently rendered comparatively harmless.

3. For direct determination of the desired voltage by voltage variation. In this case the photometer head is fixed at the point corresponding to the rated candle-power. The voltage on the test lamp is then varied until photometric balance is obtained and the correct voltage can be read from the voltmeter. In using the photometer in this way no special scales need be prepared, and variations in the characteristics of the lamp filaments do not enter in.

The transformation from a candle-power to a specific-output basis calls therefore for an instrument which shall be fitted for: (1) Measuring candles per watt; (2) the use of a volt scale to indicate the voltage for a definite candles-per-watt—commercially an instrument capable of use on single circuit is desirable; (3) determining the desired voltage by voltage variation.

The watts-per-candle meter of Hyde and Brooks[1] accomplishes the first purpose. Into the pressure circuit of a wattmeter connected with the test lamp is introduced a resistance whose quantity is varied by the position of the photometer head. At the position of photometric balance the watt meter reads watts ÷ candle-power. By the addition of a volt scale,[2] calculated from the voltage-watts-per-candle relation for the kind of lamp under test, the instrument may be used as a voltage-indicating device, fulfilling requirement 2. Requirement 3, however, is not met by this instrument unless the candle-power change with voltage is followed by manual movement of the photometer head until the watt-meter needle reads the desired point. This procedure is too slow and laborious to be recommended in factory or testing laboratory practice.

If in the instrument just described the photometer head took its position automatically, without an observing eye

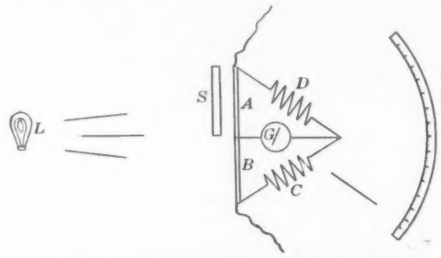


Fig. 1—Wheastone Bridge Arrangement.

and a helping hand, the third requirement would be fulfilled. This observation leads naturally to the complete statement of the problem. An instrument to duplicate, as far as possible, the performance of the visual photometer, but substituting specific output for candle-power, must indicate upon the same recording device, automatically, the two variables, watts and candle-power.

Two methods of accomplishing this have suggested themselves to the writer. First, light and power may both be measured as power; second, light and power may both be measured as light. The first possibility is perhaps rather of theoretical than of practical interest, more feasible in the physical laboratory than in a photometric or commercial laboratory. It deserves outlining, however, if for no other reason than for the light it throws on the general problem.

The sensation of light is caused by the impinging of radiant energy upon the retina. Only that radiant energy whose wave-length lies between 0.4 μ and 0.75 μ (roughly) is capable of producing this sensation, and different spectral wave-lengths are differently efficient as light. The most efficient radiation is of wave-length 0.545 μ and each wave-length may have its weight or efficiency given to it, these weights forming the luminosity curve of the eye for an equal-energy normal spectrum. Radiant energy can be measured by a suitable sensitive instrument, such as a bolometer. If before the bolometer is placed an absorbing screen whose transmission is as the luminosity curve of the eye, then the deflection of the indicating galvanometer will be proportional to light (candle-power). If the absorbing screen is absent, the deflection of the galvanometer needle is proportional to the total radiation (watts).

In Figure 1 let A, B, C, D be the four arms of a Wheatstone bridge. Arms A and B are strips of blackened metal of high temperature resistance coefficient; C and D are variable resistances; G is a sensitive galvanometer, the whole forming a bolometer for measuring the relative radiations

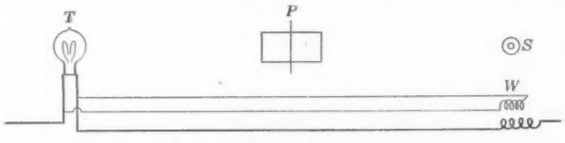


Fig. 2—Photometric Arrangement.

upon A and B. Let the radiation from the lamp L fall upon A through a visual luminosity screen S, and directly upon B. The deflection of the galvanometer needle will then be different for each ratio of radiation weighted as light to total radiation; that is, for each efficiency.

An advantage of this device would be that no comparison lamp is needed. It would be particularly sensitive for setting lamps at a desired efficiency, since by proper adjust-

[1] Hyde and Brooks, Bulletin of Bureau of Standards, 2, page 145.
[2] Ives, Bulletin of Bureau of Standards, 5, page 543.

ment of the resistances D and C the standard efficiency could be indicated by the zero position of the needle or spot of light on the scale. One disadvantage would be the inherent delicacy of the instrument, which would not recommend it to other than scientific laboratories. It could perhaps be made less delicate by dispensing with the true visual luminosity filter, with its small transmission. Actually the ratio of any two wave-lengths in a lamp of a particular type is sufficient to establish an efficiency. Probably a rough division into visible and total radiation, as by a water screen, would be satisfactory if the instrument were used by a strictly substitution method with one type of lamp at a time. Another objection, or more properly another complication, is that the total radiation is not strictly proportional to watts input, but varies with the type of filament supports as well as the character of the vacuum. Consequently lamps of the same radiant efficiency would not necessarily be of the same total efficiency.

A description of experiments on bolometric lamp rating is reserved for another paper. The present one is devoted to an application of the second possibility, namely, the measurement of both light and power as light. This has been used in a candles-per-watt meter recently constructed, a description of which follows.

The central idea is the use of a wattmeter which indicates the power consumed in the test lamp by means of the quantity of light allowed to fall on one side of a photometer. Thus, in Fig. 2, let T be the test lamp, P the photometer screen and W a special wattmeter, measuring the watts consumed by T and indicating them by the intensity of a special light source S. Under these conditions the illumination on one side of P is proportional to watts, on the other to candle-power. Remembering that the variation of watts with voltage is, in incandescent lamps, different from the variation of candle-power with voltage, one may diagram the conditions of the arrangement shown in Fig. 2 in the manner shown in Fig. 3. The ordinates represent illuminations of the photometer screen, the abscissas voltages of the test lamp. By proper choice of instrument constants it may be arranged so that at a low voltage the illumination due to watts is greater than that due to candle-power. As the voltage of the test lamp is varied both watts and candle-power increase, but the latter more rapidly than the former. In the tungsten lamp, for instance, the candle-power increases approximately as the fourth power of the voltage, the watts as the square. At some point there will be an equality of illuminations on the two sides of the photometer, then again at higher voltages an inequality. The equality point cor-

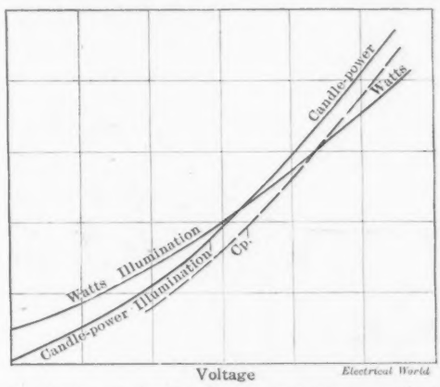


Fig. 3—Variation of Candle-Power and Watts with Voltage.

responds to a certain definite ratio of candle-power to watts. If the distance between test lamp and photometer is changed the candle-power illumination is changed, as shown by the curve cp′, and the equality point is shifted to another voltage and efficiency.

The result of this behavior is, first, that each position of the test lamp for photometric equality corresponds to a definite candles-per-watt; the instrument may therefore be used as a specific-output meter. Second, all lamps brought to the voltage to give photometric match at a given position on the photometer bar are at the same candles-per-watt; the instrument may therefore be used for finding the voltage rating, in accordance with requirement 3 above. Requirement 2 is fulfilled by any instrument fulfilling requirement 1, and so all three requirements are fulfilled.

How this scheme has been worked out practically may be

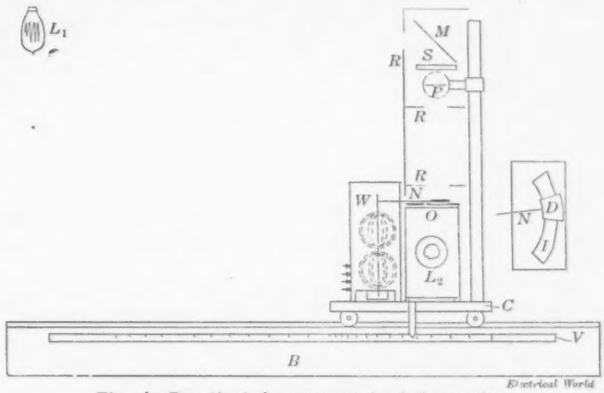


Fig. 4—Practical Arrangement of Apparatus.

understood from Fig. 4, in which B is a short photometer bench, on which moves the carriage C. Upon this carriage is an astatic oil-damped recording watt-meter movement W, connected to the test lamp L_1. Its needle N, which is provided with a broad opaque sector D, swings above an opal glass O, upon which is a thin metal sheet with a carefully calculated opening I. Below O is a comparison lamp L_2 in a metal box whose interior is painted white. The opening I is so calculated that the illumination from the portion on the "low side" of the sector O is proportional to the watts consumed in L_1. A loose opaque mat is laid over O so as to cover the opening on the high side of D. The width of D is great enough so that the opaque mat need be moved only in changing from one standard size lamp to another, as from a 40-watt to a 60-watt. The photometer P (a simple monocular equality type) is thus illuminated from below by the light from O, and from above by means of the mirror M by the light from L_1. At R, R, R, are screens, at S a variable neutral-tint absorbing screen.[3] At V is a scale, which may be either candles-per-watt (or, in accordance with current practice, watts-per-candle) or, if desired, a volt scale, calculated for the kind of lamp to be tested and for the voltage at which the test is to be made. If a volt scale is used, a desirable simplification is possible in that an ammeter may be used in place of a wattmeter.

Before describing the actual performance of the instrument a discussion of its theoretical sensibility is in order. When used for the simple measurement of efficiency its sensibility is, of course, the photometric sensibility. When used to find the voltage for a certain efficiency its sensibility is less than the photometric sensibility. Taking the carbon lamp and the tungsten lamp as illustrations, it is to be remembered that in the former 1 per cent change of voltage causes approximately 2 per cent change in watts and 6 per cent change in candle-power, consequently 4 per cent change in watts-per-candle; therefore, 1 per cent difference in brightness between the watts side and the candle-power side results from 0.25 per cent error of voltage. In the tungsten lamp 1 per cent change in voltage causes almost 4 per cent change in candle-power. The same calculations, therefore, show 1 per cent difference in brightness on the two sides to result from 0.5 per cent error of voltage. The sensibility of the instrument is therefore greater with the carbon than with the tungsten lamp, or, more properly speaking, with the low-efficiency lamp than with one of high efficiency.

[3] *Electrical World*, March 16, 1912.

One per cent may be taken as the greatest error in a simple equality photometer, such as is at present used on the instrument in question. The calculations just given would therefore indicate that in a correctly calibrated instrument the settings for voltage on a tungsten lamp should be within 0.5 per cent of each other in voltage.

The procedure with the new efficiency meter is quite

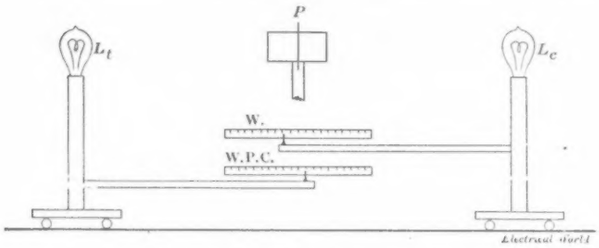


Fig. 5—Simplified Arrangement.

similar to that with a simple photometer. With a standard lamp of known efficiency at L_1, the carriage C is moved until its pointer reads the efficiency of the standard. The loose opaque mat is moved over the exposed area of I above the needle. The voltage of the comparison lamp L_2 is adjusted to a color match with L_1. Then the variable absorption screen S is rotated until a photometric match is obtained. Finally the carriage is placed to read the efficiency which is desired on the test lamps. Settings on these lamps are made by varying the voltage on them until photometric match is obtained, and the voltages are then read.

Test shows that settings on tungsten lamps rarely differ by 0.5 per cent in voltage. Two series of tests carried out with the instrument set on a 40-watt tungsten lamp of 1.17 watts per candle gave results as follows, in setting for 1.25 watts per candle:

	I.	II.
25-watt lamp	1.27	1.27
40-watt lamp	1.25	1.26
60-watt lamp	1.24	1.25

The results show that the calibration and performance of the instrument constructed are satisfactory.

The speed of working is dependent on the damping of the wattmeter needle. If this oscillates to any marked degree or is slow in coming to rest, the time required for a setting might easily be prohibitive. The ideal instrument would be one in which the needle followed a voltage change instantly and without any oscillation. The instrument as constructed, which is oil-damped, behaves very well provided the voltage is changed uniformly, without violent starts or stops. If the needle is clamped after each lamp is tested in order to avoid the initial throw from zero, accurate settings may be made in a few seconds.

A review of the requirements outlined at the beginning of this paper shows that the new instrument fulfils all, with one exception. It is not possible to use it on single circuit, for the wattmeter necessarily measures the true watts, while for single-circuit practice fluctuations of voltage should be reflected in the same changes on both sides of the photometer field. Single-circuit volt-scale practice is not, however, by any means universal. The volt-scale method is unquestionably much less accurate and reliable than the method of setting to the actual voltage desired, so that this limitation of the instrument is the least serious that could occur. Future practice, in the writer's opinion, will tend more and more, either in candle-power or efficiency rating, to the voltage-setting method, even though it involves a steadier voltage supply than some lamp factories at present possess.

In this connection it is of interest to note that a simple watts-per-candle meter, which involves no instruments other than an ammeter and a voltmeter (not necessarily on the photometer) and which uses the principle of measuring both light and power as light, may be made by modifying a common form of photometer bench. This device is not automatic, but may be used as a single-circuit volt-scale instrument.

In Fig. 5 let the photometer head P be fixed; let the test lamp L_t be put in place; let its watts be known at the bench voltage. The comparison lamp L_c may be moved to such a position that the illumination on P due to it is proportional to the watts consumed by L_t, as shown by the pointer on the scale W. When the lamp L_t is moved to the position of photometric match its watts-per-candle may be read from a properly divided scale WPC. It is, in fact, the principle of the special instrument as described in this paper worked out by hand in its simplest form. Now for the watts-per-candle scale may be substituted a volt-scale; for the watts scale a scale of amperes. If the device is to be used on single circuit, the comparison lamp L_c must be of the same type as the test lamp and the amperes of the test lamp must be read previously, at the voltage at which the photometer is run. When once the amperes are known the measurement may be carried out quickly, one operator calling the amperes as the lamp is picked up, the other setting the comparison lamp at the corresponding scale reading, then making the photometric setting, which gives the voltage on the volt scale. Separate reading of amperes is a necessary part of a single-circuit method and is not peculiar to the efficiency rating scheme just outlined.

The application of the central idea of this paper to a

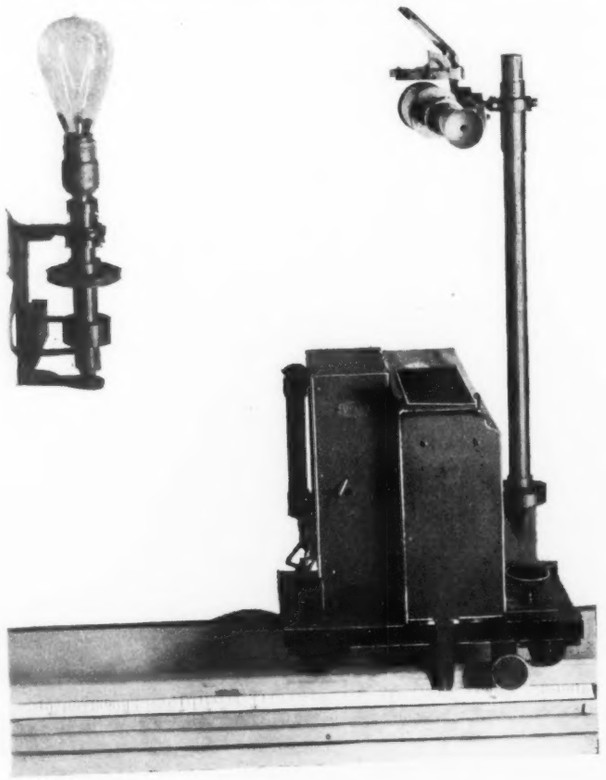


Fig. 6—Specific-Output Meter with Screening System Removed.

volt-scale single-circuit instrument is only incidental, and the scheme just described is only one of several ways of carrying it out. That type of instrument cannot for a moment compare with the automatic specific-output meter, which is applicable either for measuring candles per watt or for determining the voltage to give a required efficiency, independent of the kind or character of lamp under test

Letter to the Editors

THICKNESS OF INSULATION OF WIRES.

To the Editors of Electrical World:

SIRS:—An article in the *Electrical World*, March 16, 1912, on the thickness of the insulation of wires, attacks and condemns a prior article of the present writer in such superlative and unqualified terms that, were the criticisms just and well founded, the attack would even reflect seriously on the editor for having accepted the original article. A reader of the second article would naturally get the impression that the original one was a series of inexcusable errors from the beginning to the end, and ought therefore not to have been published and ought not to be read.

A temperate and unbiased reader, not intent upon destruction nor upon an exhibition of abstruse mathematics of the young college graduate kind, will, it is believed, see that with the exception of a few incidental remarks at the end (which were entirely foreign to the chief subject of the article) the original article is intended to show a useful and quite correct analogy between electric and thermal insulation of cylindrical bodies, like electric wires and steam pipes, with special reference to the inefficiency of the outer layers, and hence was directed to deductions which were brought out by those laws which applied to both. It therefore referred to the insulation as far as the leakage of electricity and of heat respectively were concerned, and was not an article on the disruptive strength or on dielectrics, which have no analogy in heat phenomena.

In justice to the present writer the editor will no doubt admit that the subheading containing the words "dielectric strength" was added by him and not by the author, and was not on the proof sent to the author.

The critic not only does not show a single error in this main part of the article, which means practically the whole of it, but, after endeavoring to give the impression that the whole article was entirely erroneous, he himself demonstrates that the chief conclusion was exactly correct; only he does it in a way which is apt to distract rather than to attract the average reader, and states the result in such different terms that only those who will work out the equivalence of the two statements will see that they are the same, being merely stated in different words. Such a misrepresentation can leave no excuse that it was unintentional. This is unprofessional, savoring too much of the well-known qualities of the young college graduate. The writer still believes that the less involved description of this feature adopted by him in the original article will appeal to more readers than the one adopted by the critic.

The critic then attacks in unqualified terms an incidental and unimportant remark near the close of the article (about the disruptive strength) which was entirely foreign to the real subject and was not a "conclusion" of any "argument," as the critic tries to make it appear. No attempt or argument whatsoever was made in the original article to demonstrate anything at all about the disruptive strength nor even to discuss it. It was quite sufficient for the present writer's purpose, in that incidental remark, to apply the general law that within reasonable limits the thicker the insulation the greater the resistance to break-down voltages.

It has long been well known that this as well as other similar properties deviate more or less from the fundamental general law when the curvature of the surface becomes relatively great, as in small wires; in fact, in this very feature there is again an analogy with the emission of heat, as that from very small hot wires is relatively much greater than that from flat surfaces, a fact to which the present writer himself called attention elsewhere. The greater part of the critic's attack is devoted to this feature, which was not, and was not intended to be, touched upon at all in the article.

It would be absurd to condemn a general fundamental law like the one that the resistance of a wire is equal to the length multiplied by the specific resistance divided by the section, and to imply that it is erroneous, merely because in special cases modifying factors enter, like the temperature coefficients, the skin effects, inductances, Peltier effects, Thomson effects, etc., which in some extreme cases modify the results greatly. There is probably no one of the simple fundamental laws that is not subject to such modifications due to special conditions.

In his eagerness to condemn, the critic has grossly misrepresented one of the writer's statements. The meaning which a certain statement in the original, which he attacks, was intended to convey, and in the opinion of the present writer does convey to a fair-minded reader, is that, in view of the fact that to demand a high insulation (high ohmic resistance) of a large wire seems unnecessarily extravagant, and in view of the fact that the lost current is certainly too small to be a factor, it would seem more rational to let the thickness of insulation of such large wires be governed by the disruptive strength rather than by the ohmic resistance. The critic virtually expresses agreement with this meaning of the statement, but states it in such a way that it would not be noticed unless a careful comparison is made. Had he not first misrepresented it he could not have attacked its true meaning.

The present writer admits having made one mistake, namely, in assuming fair-mindedness on the part of the reader. In view of the fact that a discussion of the disruptive strength was not involved in the subject of that article and was mentioned only incidentally at the end, as just described, a fair-minded reader who was not bent on fault-finding would have seen that that remark was based on the general law and was only approximately true for wires of greatly different sizes. As this single word "approximately" added in an unimportant remark of a general nature would have completely disarmed this critic, his unqualified condemnation of the whole article is not only not justified but is also unprofessional.

Shortly after the publication of the original article the writer urged a certain engineer to supplement it with an article dealing with this disruptive strength, which was foreign to an article intended to apply to both thermal and electric insulation.

The critic affords some amusement, unintentionally, in finally admitting, after his superlative and unqualified condemnation, that according to "true theory and practice" the final results are just about as was stated in the original article, the only difference being similar to that between subtracting a negative quantity and adding a positive one!—a difference less than between tweedledum and tweedledee.

The critic makes a certain statement in such a way as to give the impression that it had been made in the original article and then calls it "illogical." Nothing of the kind will be found in the original. Calling attention to the fact that a certain formula for cylindrical coverings applies to electric as well as to thermal insulation is not a statement that the reasons for the designing of the insulation are the same in both.

There are statements in the critic's article which could be criticised, perhaps even more justly than his criticisms were, if his intended meaning were ignored. For instance, the evidently absurd statement that "for constant outside diameter Q (quantity of electricity) is a function of $(r+a)$," when it is evident that $(r+a)$, being half of this outside diameter, is constant by definition.

Philadelphia, Pa. CARL HERING.

[The subhead of the original article was added in this office and was not submitted to the author prior to publication. This letter was received at this office in March, its appearance in our columns having been delayed by errors in mailing for which the author was not responsible. —EDS.]

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Three-Phase Series Commutator Motor.—M. Schenkel.—A continuation of his illustrated article on the three-phase series motor of the Siemens-Schuckert company. The author shows that the two requirements of a high power-factor and of stable operation of the motor at all speeds from high speed down to zero speed cannot be fulfilled simultaneously if the motor has only a single set of brushes. Both may be fulfilled if a double set of brushes are employed, one set being stationary and the other movable. The effect of this arrangement is that at low speeds the mmf of the stator prevails, and at high speeds that of the rotor. A motor of this kind has a very high power-factor, and this involves a considerable mechanical advantage, as it is possible to build the motor with a much larger air gap than induction motors. In this case some of the efficiency, perhaps 5 per cent, must be sacrificed, but this is usually permissible except in special cases. Very often a power-factor of 0.95 is practically as good as unity power-factor. The article is to be concluded.—*Elek. Zeit.*, May 16, 1912.

Three-Phase Commutator Series Motor.—L. Dreyfus and F. Hillebrand.—The first part of an article illustrated by numerous diagrams in which the authors first give the fundamental equations of the three-phase commutator series motor and then plot the circular diagram, neglecting the magnetizing current of the transformer but taking the motor saturation into consideration. They then extend the circular diagram so as to take into account the magnetizing current of the series transformer. A numerical example is added. The paper is to be concluded.—*Elek. u. Masch.* (Vienna), May 12, 1912.

Phase Advancers for Non-Synchronous Machines.—Gisbert Kapp.—The first part of a paper in which the author points out that in a non-synchronous machine the rotor current and rotor flux are in time-quadrature, and if the rotor current is made by some means to lag less than 90 time degrees behind the flux, the phase of the stator current is advanced, there is an improvement in the power-factor and an increase in the overload range. After referring to the means adopted by Leblanc to attain this end, the author considers the theory of this method, the main objection to which is that it involves the driving of an auxiliary machine to inject a suitable emf into the rotor of the non-synchronous motor, and there are some difficulties in commutation. In order to get over these objections the author has devised a vibrator for injecting this emf. In the present instalment Leblanc's methods are discussed at some length with the aid of numerous diagrams. The author's own vibrator is to be taken up in the next instalment.—London *Electrician*, May 17, 1912.

Lamps and Lighting.

Flame-Arc Lamps.—The first part of an account of the extended discussion which followed the reading of the paper by W. Hechler on the economy of modern flame-arc lamps, recently abstracted in the *Digest*. Passavant pointed out that while a specific consumption of from 0.14 watt to 0.16 watt per candle for the best flame-arc lamps is low, yet the cost of the energy is not everything, since the cost of electrodes, of attendance and of maintenance is also quite considerable. The flame-arc lamp has two competitors in the high-candle-power metallic-filament lamp and in compressed gas. The specific consumption of the metallic-filament lamp seems comparatively high, being 0.8 watt per candle—that is, about five times that of the flaming arc—but its life is more than 1000 hours, against the sixteen or eighteen hours of the open-arc lamp, and the cost of renewals, attendance and maintenance is very much less. Moreover, the consumption of the metallic-filament lamp may be still further reduced if some of its life is sacrificed. Another disadvantage of flame-arc lamps is that they must be used at a height of from 7 m to 10 m (23 ft. to 33 ft.) above the street. With sources of light of lower output, such as compressed gas lamps of from 500 cp to 1000 cp, placed at a height of from 4 m to 5 m (13 ft. to 16 ft.) above the ground, a more economical illumination of the ground can be obtained. Further advance in flame-arc lamps must depend on electrodes of higher efficiency and longer life. An improvement of from 10 to 20 per cent would not count for much. What is needed is such a progress as was made over the carbon incandescent lamp by the invention of the metallic-filament lamp. Remane emphasized that the great disadvantage of the commercial flame-arc lamp is its very high candle-power. The design of flame-arc lamps of lower candle-power would open for them a wider field of application. The account of the discussion is to be concluded.—*Elek. Zeit.*, May 12, 1912.

Tungsten Tube Lamp.—A note on "osram tube lamps," in which a drawn tungsten filament is longitudinally placed in a long glass tube, one-half of which is plated with silver so as to act as a reflector. The lamp is especially intended for illuminating show windows, pictures, etc., and is made for outputs of from 16 cp to 100 cp at from 90 volts to 135 volts.—*Zeit. f. Beleucht.*, May 20, 1912.

Arc Lamps.—A continuation of the illustrated serial on recent progress in arc-lamp construction, chiefly based on German patent specifications. The present instalment deals with regulating devices.—*Zeit. f. Beleucht.*, May 20, 1912.

Generation, Transmission and Distribution.

Norwegian Power Plant.—F. Maguerre.—A continuation of his long illustrated article on the Rjukanfos hydroelectric plant which supplies energy to electrochemical works for making nitrates from atmospheric nitrogen. The present instalment deals with the transmission line, which has to take care of 170,000 kva with a power-factor of only 0.6, but is not longer than 5 km (3 miles). The length being so short, a double voltage transformation is out of the question. The voltage at the transmitting end is 10,600; that at the receiving end is 9500. Although the original intention was to use copper conductors of 150 sq. mm (290,000 circ. mils), aluminum was finally considered to be preferable. One of the reasons for the choice of aluminum was its resistivity against the chemical effect of the atmosphere near the nitrate factory. The construction of the transmission line is described in some detail.—*La Lumière Elec.*, May 18, 1912.

Gas Analysis.—F. M. Williams.—An illustrated description of an improved form of the Orsat apparatus for gas analysis—for instance, for use in power plants—which makes it more convenient, portable and rapid in use, with a minimum liability to breakage.—*Met. and Chem. Eng.*, June, 1912.

Traction.

Three-Phase Traction in Italy.—Pietro Verole.—An illustrated article on the electrification of the Giovi line in Italy, which connects Genoa with Turin and Milan. Part of the road is of difficult construction with grades of from 2.8 to 3.5 per cent. Energy is supplied from a steam station in Genoa which contains two turbo-alternators, each of 5000 kva rating and 10,000 kva maximum, producing three-phase currents at 14,500 volts and 15 cycles. These are transmitted to four substations, where the emf is reduced to 3000 volts, two overhead conductors and the rails forming the

three leads. Electric locomotives are used, each equipped with two 1000-hp induction motors for operation in parallel to get a speed of 45 km (27 miles) per hour, or for cascade connection to obtain a speed of 22.5 km (14 miles) per hour. —*La Revue Elec.*, May 10, 1912.

Solenoids for Street-Car Brakes.—E. STEIL.—An illustrated abstract of a thesis giving an account of a repetition and extension of the experiments of S. P. Thompson and C. R. Underhill on tractive magnets and discussing their suitability in certain arrangements for braking on street-railway cars.—*Elek. Zeit.*, May 16, 1912.

Installations, Systems and Appliances.

Flat Rates.—D. BERCOVITZ.—The conclusion of his article on flat rates. The author gives the second part of his statistical table on details of flat rates used in various European and especially German stations. The table contains data on fifty-three different stations, sixteen of which are municipal and thirty-seven of which are owned by private companies. As far as known, twenty are operated by steam, twenty-one by water and two by gas. The following figures give the average rates charged for lighting and motor service. 1. Rates for lighting: (1a) Flat rate with devices limiting the maximum consumption of power: Municipal plants, $89 per kw-year (the Norwegian water-power plants not being included in the average), $72.25 per kw-year (the Norwegian plants being included), $55.75 per kw-year for the Norwegian plants alone; company plants, $89.50 per kw-year (the Holland "season plants" being excluded), $96.25 per kw-year (the Holland plants being included); mean value for the receipts of all municipal and company plants, but not including the plants of Norway and Holland, $89.25 per kw-year. (1b) Flat rate based on equipment of installations, without devices limiting the consumption: Municipal plants, $77 per kw-year; company plants, $84.50 per kw-year. 2. Rates for motor service: Municipal plants, $44.50 per hp-year (not including Norwegian plants), $32.25 per hp-year (including the Norwegian plants), $25 per hp-year for the Norwegian plants alone; company plants, $50.75 per hp-year; mean value for the receipts of all municipal and company plants, $49.25 per hp-year. The figures show that the general rate for the kw-year is less in stations which have a flat rate based on the equipment without special devices for limiting the consumption than in stations in which devices are used in which the maximum consumption is limited. This means that such stations as intend to introduce limiting devices after having had none before must raise their rate. The author then compares the financial results obtained with a flat rate with those obtained with meters and points out that the financial results can be made as satisfactory in the former case as in the latter.—*Elek. Zeit.*, May 16, 1912.

Wires, Wiring and Conduits.

Copper and Aluminum Conductors.—E. V. PANNELL.—The conclusion of his comparison of copper and aluminum for overhead-line construction. The author gives in some detail the effect of wind pressure on copper and aluminum conductors. Both formulas and diagrams are given. One of the results is that the maximum amount by which the deflection on an aluminum line exceeds that for copper is about 35 per cent. With smaller cross-section of cable than 0.1 sq. in., of course, this ratio will increase, but this illustrates the fallacy of the statement frequently made to the effect that aluminum is only suitable for small and unimportant transmission schemes. It is for the large systems that the advantages are best shown, and the greater the rate of energy transmission the better become both the technical and the economic features of aluminum. The only point open to question is the section of cable at which aluminum becomes superior to copper. The present investigation is carried down to a section of approximately 0.1 sq. in., or 100 amp carrying capacity in copper, and it does not seem that any preponderating disadvantage accrues from the displacement of copper by aluminum. If, however, the matter were carried further, down to very small cross-sections, then the large deflections necessary owing to allowance for wind pressure would cause trouble in spacing the conductors. It is emphasized, however, that the deflection is of less account than the phenomena of corona, especially in view of the rapid augmentation of corona loss, with a reduction in the size of the conductor. This fact is strongly in favor of aluminum. For not too heavy transmission lines, the A type of pole is believed to be satisfactory to take care of all stresses, and a diagram is given showing the cost of A-type wooden poles. This diagram shows that in no case does the extra cost for the poles on the aluminum lines approach the value of the saving effected on the line conductors themselves.—London *Elec. Rev.*, May 17, 1912.

Regulations on Cables.—JAMES WAGNER.—An article in which the author compares the official regulations of the German Association of Electrical Engineers and of the (British) Institution of Electrical Engineers on permissible temperature rise and permissible currents in cables. The author points out that neither set of regulations takes much account of the construction of the cable and that both leave the method of laying the cables in the earth practically out of consideration. The author proposes new tables which take these two factors into account.—*Elek. Zeit.*, May 16, 1912.

Cable Factory.—A fully illustrated description of the W. T. Henley's Telegraph Works Company's cable factories at Woolwich and Gravesend in Great Britain.—London *Elec. Rev.*, May 17, 1912.

Electrophysics and Magnetism.

Temperature and Properties of Matter.—E. F. NORTHRUP.—A paper in which the author summarizes our knowledge of the change of properties of matter from the lowest to the highest temperatures. He gives in a diagram the relation between temperatures and experimentally established facts.—*Met. and Chem. Eng'ing.* June, 1912.

Electrochemistry and Batteries.

Electric Steel Furnace.—W. R. WALKER.—A paper presented before the American Iron and Steel Institute on the extended large-scale experiments made by the United States Steel Corporation on the possibility of using the electric furnace for producing an improved quality of steel for large-quantity products. From these investigations the author concludes "that in the manufacture of steel for the so-called heavy products and steel that is produced in large quantities a combination of either the acid or basic Bessemer converter and the electric furnace will take a very prominent place. With this combination it is possible to produce steel extremely low in oxygen and other impurities at a cost that will not be prohibitive." The advantages of electric steel are the complete removal of oxygen and oxides, the freedom from segregation and the reduction of sulphur and phosphorus to 0.005 per cent if desired. Electric steel seems to have a future, especially for steel rails. "At the present time there are approximately 5600 tons of standard electric steel rails in service in the United States. These rails have been in the track about two years. During the past winter some of these rails have been subjected to very low temperatures—in some cases as low as 52 deg. Fahr. below zero—and are being exposed to all the possible conditions of severe service. It is too early to state much about the wearing qualities of these rails, but from present indications it would appear that rails made by the basic-electric process can be made somewhat softer than by either the Bessemer or basic open-hearth process and show highly satisfactory wearing qualities. Up to the present time we have not heard of any basic-electric rails in use in this country being broken in service." An account is also given of an extended discussion in which S. Wellman, T. W. Robinson and

E. B. Clark participated.—*Met. and Chem. Eng'ing,* June, 1912.

Dry Cells.—A long article on dry cells, their uses and testing, comprising a recent report of a committee of the American Electrochemical Society on dry-cell tests, an Electrochemical Society paper by Carl Hambuechen on the short-circuit current and deterioration of dry cells, and a paper by S. W. Melsom on an investigation carried out in the (British) National Physical Laboratory on the relation between the incidence of the discharge of dry cells and the relative capacity of cells of different manufacture.—*Met. and Chem. Eng'ing,* June, 1912.

Ozone for the Purification of Air in Subways.—An illustrated description of the ozone equipment for air purification in the Central London Railway, the ozone being produced by the silent electric discharge. At each station the equipment includes a rotary converter, a transformer and a motor-driven sirocco fan; accessory to these are air washers and filtering screens.—London *Electrician* and London *Elec. Review,* May 17, 1912; London *Elec. Eng'ing,* May 16, 1912.

Units, Measurements and Instruments.

Direct-Current Watt-Hour Meters on Varying Load.—S. W. Melsom and W. H. Eastland.—An account of an investigation carried out at the (British) National Physical Laboratory. The authors describe tests under working conditions on direct-current watt-hour meters of various types. These were made with currents having the character of traction loads in order to ascertain the differences which exist under such conditions. As a result, data are given regarding the effect on the constancy of calibration and the effects due to variation of voltage, stray fields and temperature coefficient. The authors made experiments on the effect of the stray fields to which meters may be subject in generating stations. For this purpose they used a coil carrying a current which was adjusted so that the field was equal to that which would be produced by a straight conductor carrying 1000 amp placed at a distance of 2 ft. from the meter. In the case of one meter there was no change in the rate owing to this field, and in another the difference was very small. In the cases of the other four meters, however, the changes at light loads were large, so as to show that this question is one of much importance. The results obtained with the various meters when they were mounted 3 deg. out of level showed that the errors at light loads are in most cases increased largely, while in one case the error at full load was altered by about 2 per cent. The temperature coefficient of all the meters tested was in no case greater than $\pm$ 0.1 per cent for a change in temperature of 1 deg. C., an amount which is probably negligible for most practical purposes. It is preferable that the main current leads to the meter should be run with the lead and return close to each other. Great care should be taken to see that good contact is made at the meters, as otherwise errors may be introduced into the readings owing to the rise of temperature in the instrument. This is a matter of great importance in the case of shunted meters, where bad contacts may lead to very large errors. In laboratory tests the following precautions must be taken: The pressure circuit should be connected to the mains for several hours before commencing the test. In addition to the usual test at various loads, made preferably with a chronograph as distinct from a stop-watch (chronograph is the name generally given to a center seconds watch, the hands of which are put into and out of gear with the movement, while by "stop watch" is meant a watch in which the whole movement is stopped or started), it is necessary that the meter should be run for a considerable time at full load in order to ascertain the extent of the error due to heating.—London *Electrician,* May 17, 1912.

Thermo-Electric Combustion Calorimeter.—An illustrated description of the new Féry thermo-electrical calorimeter. A distinctive feature of it is the fact that the heat value is read immediately from a dial without any correction. The calorimeter bomb *A* (Fig. 1) has been made as light as possible, the water mass—which in the Mahler apparatus serves as the main heat mass—being dispensed with. The bomb is kept in the center of a metal cylinder *B* by two constantan disks *KK* and forms the hot junction of a large thermo-electric element, the cold junction being constituted by the cylinder *B*. After introducing the fuel, according to

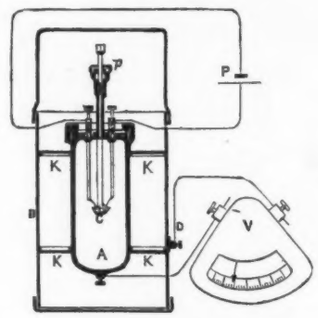


Fig. 1—Féry Thermo-Electrical Calorimeter.

usual practice, into the crucible *C*, the bomb is filled with compressed oxygen and ignited by means of the battery *P*. The deflection of the milli-voltmeter *V*, the range of which corresponds to the combustion of 1 gram of pure carbon, yields without any correction the heat value desired. The heat losses due to the conductance of the constantan disks have been made great enough to allow any losses by convection and radiation which are not proportional to the difference in temperature between the bomb and the cylinder to be neglected. The only correction left accordingly corresponds to the loss of heat due to conductance, and as this is proportional to the figure to be measured, it does not in any way alter the relative values of the deflections corresponding to each fuel.—London *Elec. Review,* May 17.

Electrometer.—R. Beattie.—In a recent article the author has given a simple explanation of the behavior of the quadrant electrometer based on the conception of an electrostatic control acting in conjunction with the mechanical control. This article was restricted, however, to the special case in which the quadrants are in conductive connection. He now shows that the same simplified theory may be used in the case in which one or both quadrants are either insulated or connected with condensers. The conception of an electrostatic control is equally applicable to this case, and it enables the necessary formulas to be written down at once.—London *Electrician,* May 17, 1912.

Measuring Insulation Resistance.—A. Dina.—A German translation of his Turin Congress paper comparing critically the different methods for determining the insulation resistance of an alternating-current system while in operation.—*Elek. Zeit.,* May 16, 1912.

Pyrometers in Steel Mills.—C. S. Gordon.—An illustrated article on the equipment of the Illinois Steel Company's Works with pyrometers and the system of regular periodic control of the instruments. The different types and makes of pyrometers which are installed are described, together with their use in the different departments of the works.—*Met. and Chem. Eng'ing,* June, 1912.

Radiation Pyrometry.—G. A. Shook.—A continuation of his illustrated serial on radiation pyrometry. In the present instalment he gives the theory of both the total-radiation pyrometer and the optical pyrometer and traces in detail the relation between optical pyrometry and photometry.—*Met. and Chem. Eng'ing,* June, 1912.

Steam Meters.—T. Pausert.—The first part of an illustrated article describing the different principles and types of apparatus for recording steam consumption.—*La Revue Elec.,* May 10, 1912.

Telegraphy, Telephony and Signals.

Wireless Telegraphy.—The conclusion of the illustrated article on the Marconi system of wireless telegraphy. The author first describes wireless-station equipment transportable on horseback, and then describes methods for erecting large steel masts and aerials. Finally some accessory apparatus are described, especially the wave meter and

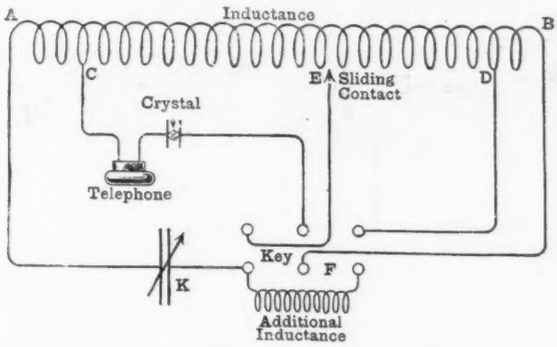


Fig. 2—Diagram of Decremeter.

the decremeter. The principle of the decremeter is shown in Fig. 2. It consists essentially of an inductance *AB*, in series with a variable condenser *K*, forming a closed oscillating circuit. A telephone and detector are connected in shunt to part of the inductance. So far the decremeter appears as a wave meter and can be used as such. It is made applicable to the determination of tuning curves and decrement by a few simple alterations. If the inductance coil *AB* is long and of small diameter (especially if the two ends are neglected), it may be assumed that the potential varies uniformly along the coil. For this reason one end of the detector circuit is connected at *C*, not at the extreme end, and a sliding contact *E* is provided. A damping or tuning curve is thus obtained by noting the position of *E* for different readings of the variable condenser, *E* being adjusted to the point where the signal is just audible. Since the strength of signal is inversely proportional to the scale reading *CE* and the wave-length is proportional to the square root of the capacity, the required curve is obtained by plotting the reciprocals of the slider readings against the square root of the condenser readings. The decrement is obtained by Bjerknes' well-known formula, involving the wave-lengths and amplitudes when the receiver is in tune and out of tune by less than 5 per cent respectively. For this purpose a throw-over switch *F* is provided, which connects in about 4 per cent additional inductance. The method then is to tap the detector circuit off a fixed inductance of thirty-two turns when the oscillating circuit is out of tune, and then to obtain an equally strong signal by adjusting the slider when the circuit is in tune. A table is supplied from which the value of the decrement can be read off when the observation is made.—London *Electrician*, May 17, 1912.

Loaded Cables.—E. F. PETRITSCH.—The first part of an article comparing the relative advantages and disadvantages of Pupin cables and Krarup cables. In Pupin cables the self-inductance is increased by inserting series-inductance coils at regular intervals in the cable. In Krarup cables the self-inductance of the cable is uniformly increased all along its length by spinning an iron wire around the copper conductors. The author gives a sketch of the historical development of both cable types and emphasizes that so far it has not yet been proved that the discontinuously loaded cable of Pupin is superior to the continuously loaded cable of Krarup. The article is to be concluded.—*Elek. u. Masch.* (Vienna), May 19, 1912.

Differential Microphone.—A note on a recent British patent (No. 21,813, May 9, 1912) of W. H. Derriman (Automatic Enunciator Company). To insure that the resistance at the opposite sides of one or more electrodes is caused to rise and fall alternately, a diaphragm is fixed with the central part on each side in granular material connected to the stationary electrodes. In the mouthpiece there is a deflector, so that the ethereal waves produced by the voice strike on the marginal portion of the diaphragm only. —London *Elec. Eng.*, May 16, 1912.

Book Review

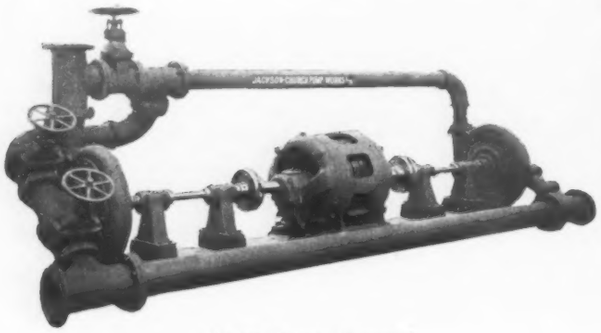
VALUATION OF PUBLIC UTILITY PROPERTIES. By Henry Floy. New York: McGraw-Hill Book Company. 385 pages. Price, $5.

An excellent work on a subject of broad public importance, prepared by an author who has been extensively engaged in valuation work. The text is well arranged in seven chapters, with a number of examples of well-known valuations presented in two additional chapters. The glossary of terms, which comprises Chapter II, is a very commendable effort to correct the loose usage which has characterized the relatively new art of making appraisals. This will serve as an excellent guide to those who take up the subject for the first time. Value, as an economic term, might have been discussed at greater length, and possibly some economists will not agree with the author's theory that usefulness or utility is a governing consideration in fixing value, although necessarily present. Chapter III, on public service commissions, contains a very good summary of the situation, including the reasons for creating such commissions and a statement of what they have accomplished. Chapter IV, on making an appraisal, and Chapter V, on structural costs, will be of substantial use to the engineer who seeks assistance in planning appraisal work. Development expenses, as the author terms them, covering promotion and organization costs, interest during construction, cost of financing, and working capital, are well treated in Chapter VI. Franchises, going value and good-will are taken up in the next chapter, with rather elaborate treatment of the theory of going value worked out by the Wisconsin Railroad Commission and also the theory applied in a number of prominent water-works cases, in which going value is defined as the cost of acquiring a given income. But no attempt is made to say the last word on this complex and much discussed question. Depreciation is elaborately treated in Chapter VIII, with considerable emphasis on the so-called sinking fund or compound interest method. A comprehensive life table applying to electric railways and central-station companies is included. The two remaining chapters give in detail the results of a number of important appraisals, which will be very useful for reference purposes. Chapter IX deals with valuations in New York City, including the cases of the Third Avenue Railroad Company, Metropolitan Street Railway Company, Coney Island & Brooklyn Railroad Company, and Kings County Lighting Company. Chapter X presents cases in other parts of the country, including the examples of the Chicago street railway properties, Union Electric Light & Power Company of St. Louis, Macon (Ga.) Gas Light & Water Company, steam railroads in the State of Michigan, and the Beloit (Wis.) Water, Gas & Electric Company. Throughout the book frequent references are made to the more important court decisions, which are generally regarded as establishing legal precedents in valuation work, and numerous extracts are quoted. As a whole the author's work deserves the highest praise and appreciation. When the opportunity presents itself for revision, however, the debatable questions connected with depreciation and going value might be more comprehensively treated. At the same time the index should be considerably enlarged.

New Apparatus and Appliances

MOTOR-DRIVEN PUMP.

Illustrated herewith is a motor-driven pumping unit adapted for either series or parallel operation, consisting of two centrifugal pumps directly connected to a multi-speed motor, all mounted upon a common base. This arrangement provides a flexibility of operation desirable in many classes of service. The equipment shown here is in use



Motor-Driven Pump.

in the pumping plant of the Woodlake Development Company, at Woodlake, Cal. It was designed by the Crocker-Wheeler Company, Ampere, N. J.

COMPACT REMOTE-CONTROL SWITCHBOARD.

The switchboard illustrated herewith has been installed at Mare Island Navy Yard, San Francisco, and consists of nineteen panels of blue Vermont marble. All of the panels are either 16 in. or 24 in. wide, being much smaller than the panels usually found in a board for such service. Included in the equipment are sixty-three meters, the 16-in. panels having two meters mounted thereon in a horizontal line and the 24-in. panels having three meters mounted in a horizontal line—a form of construction that is very desirable and, of course, entirely impossible with larger diameter meters. The total length of the board is 28 ft. Had

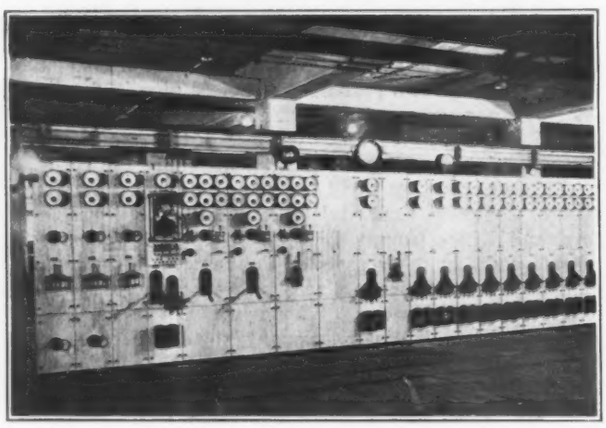


Fig. 1—Front View of Remote-Control Switchboard.

the ordinary 9-in. meters been used, the length would have been 25 per cent greater, or a total of 35 ft., involving consequently greater expense and floor area. The use of the smaller meters in this case meant a saving therefore of 7 ft. of floor length and 56 sq. ft. of marble and also meant much less distance to be covered by the attendant in operating the board. The board controls one 1000-kw and two 500-kw, 2300-volt, three-phase, 60-cycle generators with exciters. Provision is made for the future installation of a 2000-kw generator. A voltage regulator is mounted on a panel con-

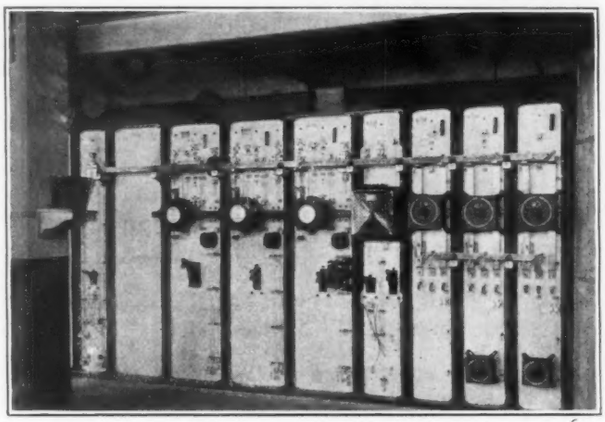


Fig. 2—Rear of Remote-Control Switchboard.

taining the control apparatus for the induction motor driving one of the two exciters. In Fig. 2 is shown a view of the rear of the board, indicating the neatness of the arrangement of wiring made possible by the use of remote-control apparatus with consequent absence of heavy wiring, busbars and oil-circuit breakers from the back of the board. Another point of particular interest is the mounting of the watt-hour meters on the back of the board, where they are very accessible and at a convenient height to be read. The board and instruments were supplied by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

LOW-VOLTAGE LIGHTNING ARRESTER.

An excellent lightning arrester for low-voltage circuits is one of the electrolytic type. This type of arrester has two essential characteristics, due to a film of hydroxide of

Low-Voltage Lightning Arrester.

aluminum deposited on aluminum plates or trays, that enable it to fulfil the conditions required. These essential characteristics are that it automatically offers a very high resistance to currents at normal voltages and a very low resistance to currents above a certain critical voltage, and that it possesses the properties of a condenser, offering high

effective resistance to currents at low frequency and low effective resistance to currents at the high frequencies that are prevalent in lightning discharges.

The decrease in resistance occurs very rapidly at a certain critical voltage, so that for currents at double the normal voltage the film offers practically no resistance to the flow of current; but when the excessive voltage ceases the resistance is instantly restored and no power current follows the discharge nor is there any arcing.

A design of an electrolytic arrester for railway work has recently been placed on the market by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., built in two styles, for 600-volt and 1500-volt circuits.

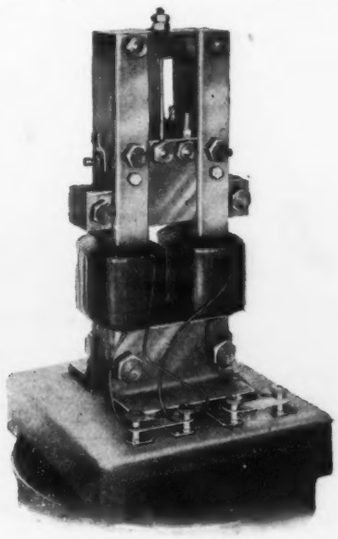
The arrester consists of a tank of oil in which are placed, on properly insulated supports, a nest of cup-shaped aluminum trays. The spaces between the trays are filled with electrolyte. The top tray is connected with the line through a 60-amp fuse, and the bottom tray is connected to the tank, which is thoroughly grounded by means of a lug. A fuse of the inclosed type is mounted on the cover of the arrester.

A small charging current flows through the trays continuously and keeps the films on the trays built up, so that no other charging is required. This charging current is not, however, of sufficient value to raise the temperature appreciably.

The effectiveness of a lightning arrester is largely affected, as explained above, by the resistance it offers to the discharge, and in an electrolytic arrester this depends on the area of the aluminum plates. It should, therefore, be borne in mind that the degree of protection is largely dependent on the aluminum plate area, while the integrity of the arrester under hard service and varying line voltage demands large thermal capacity and radiating surface in order to prevent any temperature rise.

FATIGUE TESTER.

Herewith is illustrated a device for subjecting samples of steel to any desired mechanical stress at the rate of say 120 applications per second for any desired period of time. By means of this device material exhibiting the minimum of fatigue can be selected when desired. The stress on the sample is produced by the magnetic attraction of an electro-

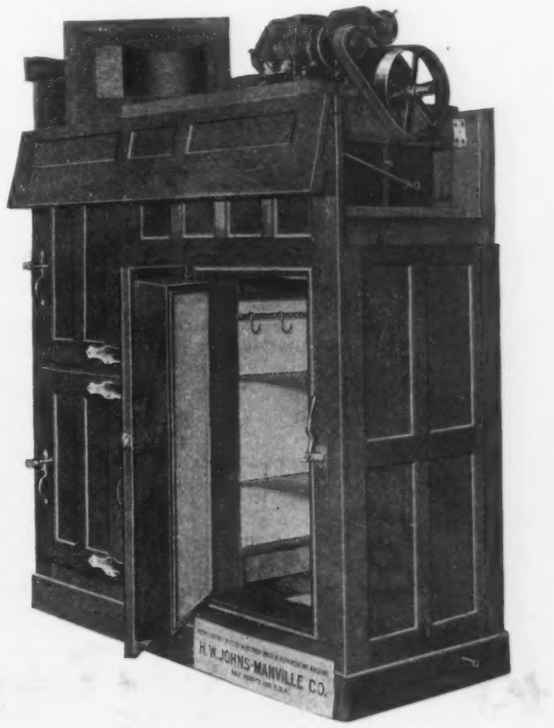


Fatigue Tester.

magnet on its armature. One end of the sample is held in the frame of the machine, while the other supports the armature at a short distance from the polar faces. The magnetic attraction is thus transmitted to the sample. The electromagnet is energized by an alternating current, the frequency of the application of the stress being therefore twice the frequency of the alternating current. Thus, in the case of a 60-cycle circuit, 120 stresses are applied to the sample per second. As long as the armature is held just clear of the polar faces the magnetic pull is proportional to the square of the voltage applied to the terminals of the magnet, and slight changes in the clearance between the magnet face and the armature do not alter the attractive force. It is thus easy to regulate the magnitude of the stress by simply adjusting the voltage applied to the winding of the magnet. Should the material be stressed so that a slight elongation of the sample is produced, the armature is then let down on to the poles and the machine begins to rattle, thus announcing that the yield point has been passed. The above-described fatigue tester has been placed on the market by the General Electric Company, Ltd., 167 Queen Victoria Street, London, England.

MOTOR-DRIVEN REFRIGERATOR.

Hot weather bringing with it a decrease in the hours of artificial lighting, central stations find it advantageous to encourage the use of motor-driven refrigerating machines in order to maintain the load on their generating equipment during the summer season. Herewith is illustrated a refrigerating equipment especially adapted to create a demand for energy from the central station among residences, hotels, clubs, cafés, creameries, dairies, butcher and grocery stores, hospitals, etc. The supplying of energy for these small refrigerating and ice-making machines offers business to the central station in the form of a summer load as against a winter load, a day load as against a night load, and a load that can be cut out entirely during the peak-load period. The power required ranges from 0.25 hp to 4 hp, depending upon the cooling effect or ice-making capacity of

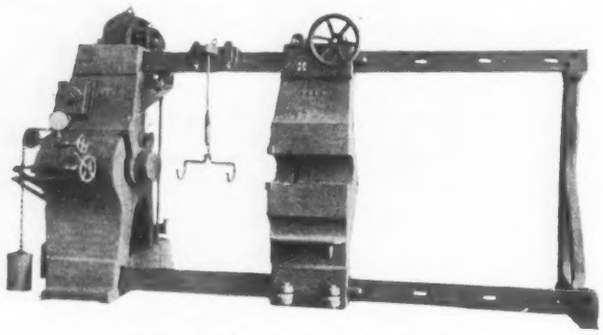


Motor-Driven Refrigerator.

the machine. The machine is built in the form of a dumb-bell, with a pulley on the end and with a hollow shaft connecting the two bells. Use is made of sulphur dioxide as the refrigerating medium. This equipment, which is of the Audiffren-Singrun type, is being marketed by the H. W. Johns-Manville Company, New York.

MOTOR-DRIVEN HYDRAULIC WHEEL PRESS

The accompanying illustration shows a wheel press which, it is claimed, possesses several novel features. It is equipped with low-pressure and high-pressure pumps, the former operating the ram rapidly until a pressure of 50 tons is reached, when the high-pressure pump is automatically connected and continues the operation at a slower rate. An extra valve to connect with the city water line is furnished. By opening this valve the ram is moved toward the work more rapidly than could be done by the pumps. When the ram is in the proper place this valve is closed, the pump valve opened and the plungers started.



Motor-Driven Hydraulic Wheel Press.

The ram is drawn back automatically as soon as the pressure is shut off. A safety valve is provided to prevent overloading. The plungers, which are not shown in the illustration, are operated by eccentrics on the back shaft and are driven by a 7.5-hp direct-current motor. For convenience in handling heavy work the upper horizontal parallel bar is not placed directly above the lower, but at a slight angle, which permits handling the work with an overhead crane. The press is manufactured by E. R. Caldwell, Bradford, Pa., and the motor by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

READY-TO-HANG FIXTURES.

For some years there have been on the market fixtures so constructed and packed that risk and trouble of handling was reduced to the minimum. Many improvements on the former arrangement are embodied in the ready-to-hang fixtures here illustrated. The new line is, of course, packed in cartons, the four-lamp unit requiring a box-board container only 6 in. by 6 in. by 22 in. over all. As the unit comes from the carton it is complete, the shells, sockets and holders being attached; there are no missing parts, for nothing is packed separately. The bottom shell is removed by unscrewing a thumbscrew, then the binding screws are loosened to permit the arms to be inserted in the body frame. The arms are slotted to engage a raised ridge in the body plate, which clamps and holds them when the binding screws are tightened. The body shell is then attached with thumbscrew and the unit is complete. Many small refinements have been made to add to the practical value of the unit as a stock proposition for the electrical contractor or fixture dealer. For example, the threaded terminal which locks the shell in place has a threaded stud which may be removed for a pendent switch cord if desired. Another point is that the four binding screws which fasten the body plates together and secure the arms in place are flanged on the ends so they cannot drop out. A careless workman cannot waste time by running the screws entirely out of the plates and deranging the body or losing screws. The flange makes the unit "foolproof." The compactness of the above-described fixture, the impossibility of damage to shells or finish, the fact that there can be no lost parts and that the labor of assembling is almost nothing, combined with the low price, make it very profitable for the contractor who has no facilities for entering the regular fixture business but who has frequent opportunity to install standard units for commercial and residence use. These fixtures have been developed by the Tungstolier Company, Conneaut, Ohio.

Fig. 1—Fixture as Removed from Carton.

Fig. 2—Inserting Arms in Body Plate.

Fig. 3—Fixture Completely Assembled.

Industrial and Financial News

ADVICES on crop conditions throughout the country indicate that the outlook for good harvests is becoming more promising. Statements made this week by railroad officials and others who have traversed the agricultural districts are highly optimistic, and these views have been confirmed by reports from manufacturers of harvesting machinery of substantial increases in orders for their products. Estimates by the Department of Agriculture in its first cotton report of the season, issued this week, place the condition of the growing crop as of May 25 at 78.9 per cent of the normal. In spite of these favorable elements, the trade situation is still irregular. That uncertainty as to the future exists is seen from the record of new incorporations in the month of May, cited on the following page, which shows a decided falling off from the total of the preceding month. Political and labor dissension is helping to check advancement. While progress is being made, it seems certain that it will continue to be made but slowly for several months to come. Money market conditions show no change of moment. Rates in New York June 5 were: Call, 2½@2¾ per cent; ninety days, 3@3½ per cent.

To Erect Steam Turbine Auxiliary Plant at Saanich, B. C.—In addition to the new hydroelectric generating station recently completed on the Jordan River, Vancouver Island, B. C., the British Columbia Electric Railway Company has found it expedient to erect another new station on the island at Tod Inlet in order to take care of the rapidly increasing railway and lighting load in Victoria and its new interurban line now building between Victoria and the Saanich peninsula. Messrs. Charles C. Moore & Company, of San Francisco and Seattle, have just signed a contract with the railway company covering the station and its equipment. There will be two 2000-kw Allis-Chalmers turbine units fitted with surface condensers and connected to generators wound for 2300 volts, 60 cycles. The steam equipment will comprise six Babcock & Wilcox boilers fitted with superheaters and oil burners. The station structure will be of reinforced concrete, and the stack, of similar construction, will be 248 ft. high and 11 ft. in diameter at the top. In addition the company will install a 1000-kva motor-generator set for railway service. The Saanich Inlet line will be 22 miles long.

Electric Bond & Share Enlarges Texas Holdings.—Further data concerning the Texas Power & Light Company, recently formed by the Electric Bond & Share Company, 71 Broadway, New York, to purchase a number of gas and electric properties in Texas, as noted in these columns May 18, 1912, are now available. The new company is capitalized at $13,000,000 and in addition to taking over the properties at Cleburne, Hillsboro, Waco and Waxahachie, Tex., mentioned in the May 18 account, will also purchase immediately from J. F. Strickland and associates the Temple Light & Power Company, of Temple, Tex.; the Sherman Electric & Gas Company, of Sherman, Tex., and the Bonham Electric & Gas Company, of Bonham, Tex. The plans of the new company for building a large central station at Waco to supply energy throughout the territory now served by the several companies purchased, and to furnish energy for the interurban line to be built and operated in the vicinity by the Strickland interests, were also given in the May 18 issue of the *Electrical World*.

Snake River Development at American Falls, Idaho.—The Idaho Consolidated Power Company, of Pocatello, Idaho, has commenced excavating for its new development on the Snake River at American Falls, 25 miles west of Pocatello. The same company has operated a small water-power plant for a number of years at American Falls, the total power of which is estimated at 40,000 hp. A head of 52 ft. will be developed by the new station, which is laid out for seven 4500-kw units, although only one set, an Allis-Chalmers waterwheel driving a General Electric alternator, will be installed at first. The concrete building for the power house, which is 300 ft. long, will be ready for placing the machinery Nov. 1, and the plant is expected to be in service during the coming winter. The output of the station will be stepped from 2300 volts up to 33,000 volts, for transmission to Pocatello, Black Foot and Ross Fork, a total distance of 50 miles. J. H. Brady is president of the Idaho Consolidated Power Company and M. E. Hughes is vice-president, treasurer and general manager.

New Equipment for Cleveland Company.—To equip the five new substations which it is building as the result of its contract to obtain electrical energy at wholesale from the Cleveland Electric Illuminating Company, the Cleveland Railway Company has ordered from the Westinghouse Electric & Manufacturing Company nine 1500-kw, 60-cycle rotary converters and two 1000-kw, 60-cycle rotary converters of special design. It is said that the 1500-kw machines are the largest 60-cycle rotaries ever built. An order has also been placed with the same manufacturer by the Cleveland Railway Company for twenty-eight air-blast 550-kva, single-phase transformers to be connected to 11,000-volt primary circuits; also for seven 375-kva, 1500-cu. ft. motor-driven blowers and two 800-ft. blowers of the same type.

New York Telephone Bonds.—The proceeds of the $20,000,000 first and general refunding mortgage bonds of the New York Telephone Company which were offered for sale here and abroad last week, as noted in these columns, will be used for the purchase of properties in Virginia and West Virginia and for improvements outside New York State. An issue of $5,000,000 has been authorized by the Public Service Commission for the Second New York District, the proceeds of which will be used as follows: Additional substation equipment, $1,050,000; additional exchange lines, $2,150,000; central-office equipment, $1,000,000, and expenditures to complete office buildings in New York and Buffalo, $800,000.

Will Promote Industries Near Keokuk Dam.—Permanent organization of an association to promote the industries of the cities close to the dam of the Mississippi River Power Company will be effected June 17 at a meeting at Hannibal, Mo. The purpose of the organization is to advertise the advantages of the district for industrial purposes. At a meeting held in Keokuk on May 22 representatives were present from commercial associations at Quincy, Burlington, Fort Madison and Keokuk, Ia., and Hannibal, Mo.

To Issue McCrum-Howell Receivers' Certificates.—Authority has been given to the receivers for the McCrum-Howell Company to borrow funds up to the amount of $500,000 and to issue receivers' certificates therefor, in order to continue the business as a going concern. The time for depositing the securities of the company has been extended to June 15. It is understood that no plan for reorganization has yet been decided upon.

Foreign Tariff Notes.—The United States Department of Commerce and Labor has issued a bulletin under the head "Foreign Tariff Notes," containing reprints of data on tariff matters contained in the "Daily Consular and Trade Reports" from Feb. 16 to April 9, 1912. Proposed tariff changes, import and export duties, foreign tariff systems and customs regulations of various countries are among the topics discussed in the bulletin.

Contract for Arc-Lamp Brackets.—The Board of Trustees of the Sanitary District of Chicago has awarded to the Modern Steel Structural Company a contract for 2000 or more malleable-iron brackets for arc lamps to be used in the street-lighting system of the city of Chicago. The price of each bracket, painted and delivered, is $8.72.

Niagara Falls Power Company Financing.—Application has been made to the Public Service Commission for the Second New York District by the Niagara Falls Power Company for permission to issue $3,567,000 in bonds or stock. The proceeds will be used for improvements.

Doherty Company to Acquire Natural Gas Holdings.—H. L. Doherty & Company, 60 Wall Street, New York, have agreed to pay $135 per share for the $1,089,000 outstanding capital stock of the Dominion Natural Gas Company, Ltd., of Pittsburgh, Pa.

Hydroelectric Plans of American Water Works & Guarantee Company.—Plans will be announced shortly by the American Water Works & Guarantee Company in connection with the construction by this company and allied interests of a large hydroelectric development near Pittsburgh, Pa. As previously noted in these columns, the work of acquiring water-power sites on the Cheat River in West Virginia, about 50 miles from Pittsburgh, has been in progress for some time. With the property and rights now held in the Cheat River section, more than 100,000 hp can be developed there when the installation is completed. As stated in these columns last week, the American Water Works & Guarantee Company recently issued $10,000,000 6 per cent cumulative participating preferred stock. Part of the proceeds of this issue will be expended on this hydroelectric development. A large part of the energy from the Cheat River project can be absorbed by the railway and lighting systems of the West Penn Traction Company, a majority of the stock of which is owned by the American Water Works Company, in addition to the local demand in West Virginia and Pennsylvania. The West Penn company operates 209 miles of track and supplies lighting and motor service in 110 cities and towns in the Pittsburgh district within a distance of from 30 to 60 miles of the city. The equipment in its main power station at Connellsville, Pa., has a rated output of 42,000 hp. Additional equipment, bringing this to a total of 55,000 hp, will be installed shortly. J. S. & W. S. Kuhn, Inc., fiscal agents for the American Water Works & Guarantee Company, announced early this week that the $10,000,000 preferred stock referred to above was largely oversubscribed.

Growth of Public Utility Earnings Since 1907.—Harris, Forbes & Company, bankers, at Pine and William Streets, New York, who are fiscal agents for seventy public service corporations operating in various parts of the United States, have prepared a table summarizing the increase in gross earnings of these corporations each year since 1907. This table shows that sixty companies increased their total gross earnings in 1908 over those in 1907 by 7.3 per cent; that sixty-one companies gained 11.3 per cent in 1909 over the returns in 1908; that sixty-six companies showed a gain of 12 per cent in 1910 over 1909, and that seventy companies increased their gross earnings in 1911 by 9.3 per cent over the returns of 1910. The tabulation for the 1911-1910 period is given in abundant detail and shows that the gross earnings of seventy corporations, each of which has a gross income of at least $100,000 per year, were $266,954,444 in the fiscal year ended Dec. 31, 1911, as compared with $244,094,360 in the year ended Dec. 31, 1910, an increase of $22,860,038, or 9.3 per cent as above. Dividing the corporations into four classes, the analysis also shows that the earnings of twenty-five electric railway companies increased 10.3 per cent in 1911 over those in 1910; that those of thirty-seven gas and electric companies increased 8.4 per cent in the same period; that those of five telephone companies increased 9.5 per cent, and that those of three water companies were 10.9 per cent larger in 1911 than in the preceding year.

A New Company to Deal in Public Service Bonds.—New York and Philadelphia interests have organized a new concern known as the Securities Corporation General, whose function will be the underwriting of the securities of public service corporations. The capitalization will be $10,000,000, divided into $5,000,000 5 per cent cumulative preferred stock and $5,000,000 common. The common has been placed in a voting trust for a period of five years, the trustees being Edward D. Toland, president of the Trust Company of North America, Philadelphia; S. Z. Mitchell, president of the Electric Bond & Share Company, 71 Broadway, New York, and P. M. Chandler, of Chandler Brothers & Company, 111 Broadway, New York. The latter is president of the new concern. W. H. Sharp is its vice-president, and J. K. Trimble is its secretary and treasurer. The directors are Caldwell Hardy, Alexander J. Hemphill, Howard A. Loeb, S. Z. Mitchell, Fergus Reid, George W. Robertson, F. W. Roebling, Jr., William H. Sharp, Edward D. Toland, J. G. White, P. M. Chandler and F. P. Chandler. The members of the executive committee are A. J. Hemphill, S. Z. Mitchell, Howard A. Loeb, George W. Robertson and Percy M. Chandler.

Financial Status of Electric Bond Deposit Company.—A statement issued recently shows that the Electric Bond Deposit Company now has in its treasury $1,500,000 first-mortgage forty-year 5 per cent bonds, $375,000 6 per cent cumulative preferred stock and $262,500 common stock of the Ozark Power & Water Company. These securities have been issued by the Ozark company to finance the first development of the 15,000-hp hydroelectric plant which it is building on the White River near Forsyth, Mo., as described in these columns Feb. 24, 1912. The Electric Bond Deposit Company, as explained at that time, was organized by H. L. Doherty & Company for the purpose of purchasing and holding underlying issues of electric and gas enterprises and selling these securities when their market values shall have become established. The plant is to be completed and in operation by April 1, 1912, together with the transmission lines to Springfield, Mo., and adjacent territory. Details of the plan to connect in and feed the excess energy to the distribution system of the Empire District Electric Company at Joplin, Mo., have been previously announced in the *Electrical World*.

More Long Acre Electric Light & Power Company Plans.—A. B. Leach & Company, 149 Broadway, New York, will make an announcement within a few days concerning the financing and operation of the Long Acre Electric Light & Power Company, which has been endeavoring for some time to supply energy in New York City in competition with the New York Edison Company. Future developments will depend upon the outcome of litigation now before the Supreme Court, in which the Edison company is opposing the action of the Public Service Commission in giving authority to the Long Acre company to operate in the city. It is rumored that arrangements are being made by the Long Acre company to secure energy from the Hudson & Manhattan Company, but officials of neither of the companies interested will disclose any information on the subject.

May Incorporations.—Compilation by the *Journal of Commerce*, New York, shows that papers filed in the Eastern States in May by companies with an authorized capital of $1,000,000 and over aggregated $145,284,000. This total represents a decrease of $136,173,000 as compared with the April total and a decrease of $17,911,000 as compared with that of May, 1911. Charters taken out during the month by other companies with an individual capital of $100,000 or over, but less than $1,000,000, brought the total for May up to $239,531,999, which compares with $370,184,500 in April and with $326,144,000 in May a year ago.

American Gas & Electric Common Stock Subscriptions.—Common stockholders and holders of voting trust certificates for common stock of the American Gas & Electric Company have been notified that the recent temporary injunctions restraining the company from issuing any new common stock or receiving any subscriptions therefor pending court decisions have been dissolved, and that the company is now in a position to receive subscriptions for such new stock.

Consolidated Gas & Electric (Baltimore) Debentures Forthcoming.—It is understood that the Consolidated Gas, Electric Light & Power Company, of Baltimore, will issue next week the debenture stock which was authorized at the last session of the Maryland Legislature. James E. Aldred, president of the company, who has just returned from abroad, reports that there is a demand for the stocks of the company on the London exchange.

Foxboro (Mass.) Electric Company to Issue Stock.—The Foxboro Electric Company, of Foxboro, Mass., has been authorized by the Gas and Electric Light Commissioners to issue 1363 shares of additional stock. Of these, 938 are for the purpose of consolidating the company with the Union Electric Light Company, of Franklin, and 425 shares are for the retirement of promissory notes issued for immediate extensions.

Recommends Federal Incorporation Act.—The National Chamber of Commerce, formation of which was noted in these columns April 27, has urged upon the judiciary committee of the House of Representatives a federal incorporation act which embodies ideas recently recommended by President Taft.

Great Western Power Company Increases Stock.—The Great Western Power Company has increased its capital stock from $25,000,000 to $27,000,000.

Oppose Allis-Chalmers Reorganization Plan.—Interests headed by E. P. Chalmers have instituted a suit to block the foreclosure proceedings which were brought against the Allis-Chalmers Company last week by the Continental Trust & Savings Bank of Chicago in accordance with the reorganization plan, as noted in these columns in the previous issue. A member of the reorganization committee stated to a representative of the *Electrical World* this week that the depositing of securities under the reorganization plan was nearly unanimous, so that, while some delay might result from the opposition suit, in which the taking of testimony has begun, the security holders represented by Mr. Chalmers were in such small minority that no serious difficulties were expected. The business of the company has been prospering under the direction of the receivers, a gross business of $500,000 for November last having been increased to an average of over $900,000 monthly for December, January, February, March and April, and this showing is expected to aggregate $1,300,000 for the month of May. An order for reciprocating engines was booked in May for the first time in two years. This order called for twenty engines. These statements were made recently by a member of the reorganization committee, who added that the company is on better working terms with its competitors and that with realization of the improvement expected in general business the outlook for the Allis-Chalmers will be, comparatively speaking, quite bright.

Commonwealth Water & Light Company (N. J.) Sells Notes.—New York and Philadelphia interests are offering $100,000 5 per cent serial notes of the Commonwealth Water & Light Company, of Summit, N. J., the proceeds of which will be used in part for new water mains and a 500-kw turbo-generator. The company is capitalized at $700,000. Its authorized bond issue is $1,000,000, of which $980,000 is outstanding, including $60,000 in the treasury. These bear 5 per cent and are due Aug. 1, 1934. The company furnishes water, and electric energy for lighting and motor service in a number of New Jersey towns and cities, including Lakewood, Summit and New Providence Township. Its gross earnings in 1911 were $304,320, as compared with $271,309 in 1910.

Large Central Station Contract in Maine.—The Central Maine Power Company, of Waterville, Me., has entered into a contract with the Rockland, Thomaston & Camden Electric Railway Company to furnish the latter with energy for its lighting, traction and motor-service requirements for a term of twenty years. A 30-mile transmission line, over private right-of-way, is to be constructed from the power stations at Winslow and Warren to furnish energy to the traction company.

Financing New Plant at Lowellville, Ohio.—The Republic Construction Company, a new subsidiary of the Mahoning & Shenango Railway & Light Company, has filed a first mortgage in Mahoning County, Ohio, covering $2,000,000 5 per cent bonds maturing in 1922. This mortgage will cover the new plant to be built at Lowellville, Ohio, as noted in these columns last week, for the Republic Railway & Light Company, which controls the Mahoning company.

Butte (Mont.) Electric & Power Company Redeems Bonds.—Notice has been given by the Butte Electric & Power Company, of Butte, Mont., that pursuant to sinking-fund provisions $20,654 has been deposited with the trustee, and that bids for the sale of bonds of the company maturing June 1, 1951, for this amount will be received by the United States Mortgage & Trust Company, the trustee, until June 20, 1912.

Susquehanna Power Developments.—Arrangements are being made by the Susquehanna Power Company for construction of a dam across the Susquehanna River in keeping with plans for extensive hydroelectric developments it has had under consideration for some time. This dam, it is understood, will be about 10 miles below that of the Pennsylvania Water & Power Company at McCall's Ferry, Pa.

Southern California Edison Earnings Up.—During the month of April gross earnings of the Southern California Edison Company showed an increase of $58,649, and those for the four months ended April 30 showed a gain of $212,648 as compared with those in the corresponding periods of the previous year.

Jackson (Miss.) Light & Traction Bonds Offered.—New York and Boston interests are offering $700,000 first-mortgage sinking-fund 5 per cent gold bonds of the Jackson (Miss.) Light & Traction Company, due April 1, 1922, at 96 and interest to net over 5.50 per cent.

Sale of London (Ont.) Electric Light Company.—A syndicate headed by Sir William MacKenzie has purchased the London Electric Light Company, of London, Ont. An offer of $50 a share was made to the stockholders of the company by the syndicate.

REPORTS OF EARNINGS.

PORTLAND (ORE.) RAILWAY, LIGHT & POWER COMPANY.

A statement of the earnings of the Portland Railway, Light & Power Company, of Portland, Ore., for April and the four months ended April 30 compares with that for the corresponding periods of the previous year as follows:

	1912.	1911.	Increase.
Gross earnings	$532,558	$526,475	$6,083
Net earnings	254,862	280,430	*25,568
Surplus	87,754	159,199	*71,445
Four months:			
Gross earnings	2,125,836	2,032,114	93,722
Net earnings	1,021,091	1,034,099	*13,008
Surplus	447,347	542,593	*95,246

*Decrease.

MONTREAL LIGHT, HEAT & POWER COMPANY.

The income account of the Montreal Light, Heat & Power Company for the fiscal year ended April 30, 1912, compares with that for the preceding year as follows:

	1912	1911
Gross earnings	$4,969,255	$4,404,126
Expenses	2,125,239	1,827,786
Net earnings	$2,844,015	$2,576,340
Interest	485,746	472,051
Balance for dividends	$2,358,269*	$2,104,289
Dividends	1,360,000	1,275,000
Depreciation and insurance funds	500,000	476,011
Surplus for the year	$498,269	$353,278

*Equal to 13.87 per cent on $17,000,000 capital stock as compared with 12.38 per cent in preceding year.

EDISON ELECTRIC ILLUMINATING COMPANY OF BROOKLYN.

A statement issued this week by the Public Service Commission for the First New York District gives some data regarding the operations of the Edison Electric Illuminating Company of Brooklyn in the fiscal years 1911 and 1910 in addition to that which appeared in these columns Feb. 24, 1912, relating to the annual report of this company for 1911. This statement shows that the sales of electric energy in those two years compared as follows:

Sales of Electric Energy in 1911.	Kw-hrs. Delivered.	Net Revenue.	Increase.
Municipal street lighting	12,962,070	$537,345	$32,665
Lighting municipal buildings	1,917,860	140,272	*4,589
Municipal heat and power	645,759	63,587	4,077
Commercial metered lighting	34,721,050	2,978,163	334,361
Commercial metered power	22,799,230	953,442	95,666
Miscellaneous energy	3,771	375	50
Breakdown service	531,575	26,578	*5,403
Total sales	73,581,315	$4,699,764	$456,827
Other income, sales and rental of appliances, etc		8,150	1,146
Total operating revenue		$4,707,914	$457,973

*Decrease.

The data on plant, equipment, load, etc., show that the station apparatus includes 56 boilers, with a total rated output of 35,300 hp; eight engines, rated at 50,920 hp; four turbo-units with a rated output of 30,000 kw, and four alternating-current generators with a combined rated output of 10,500 kw. The total connected load as of Dec. 31, 1911, in 50-watt equivalents was 2,142,064, an increase of 105,591 over 1910. During the year 105,629,324 kw-hr. were generated.

The number of officers is given as five, and their total compensation during the year as $34,033. The total compensation paid to officers and employees during the year—there being about 1800 employees—was $1,465,492, which was charged as follows: To operating expenses, $862,536; to fixed capital, $55,208; to uncompleted work done, $493,331, and to other accounts, $54,416.

PRICES IN THE NEW YORK METAL MARKET.

Copper:	May 28 Bid.	May 28 Asked.	June 4 Bid.	June 4 Asked.
Standard:				
Spot	16.10	16.30	16.50	17.00
May	16.17½	16.35	....	....
June	16.37½	16.50	16.50	17.00
July	16.35	16.50	16.50	17.12½
August	16.35	16.50	16.50	17.12½
September	16.35	16.50	16.50	17.12½
London quotation:	£ s d		£ s d	
Standard copper, spot	74 12 6		77 2 6	
Standard copper, futures	75 2 6		77 13 9	
Prime Lake	16.62½		17.12½	
Electrolytic	16.50		17.00	
Casting	16.25		16.70	
Copper wire, base	17.50		17.75	
Seamless tubing, copper, base	23.00		.....	
Seamless tubing, brass, base	20.00		.....	
Lead	4.20		4.20	
Sheet zinc, f.o.b., smelter	8.65		8.65	
Spelter, spot	6.92½		7.00	
Nickel	39.00 to 40.00		39.00 to 40.00	
Aluminum:				
No. 1 pure ingot	21@22		21@22	
Rods and wire, base	31		31	
Sheets, base	33		33	
OLD METALS.				
Heavy copper and wire	14.75		16.00	
Brass, heavy	10.00		10.25	
Brass, light	8.25		8.50	
Lead, heavy	4.00		4.05	
Zinc scrap	5.75		5.75	

COPPER EXPORTS IN JUNE

Total tons, including June 5	3,799

STOCK MARKET PRICES

	May 29.	June 5.
Allis-Chalmers	7/8	7/8*
Allis-Chalmers, pf.	2¾	2¾*
Amalgamated Copper	82¾	85⅞
Amer. Tel & Tel.	145⅝	145⅞
Boston Edison	283	....
Commonwealth Edison	141	138¼
Electric Storage Battery	55¾	55¼
General Electric	171	170½
Mackay Companies	83½	87⅝
Mackay Companies, pf.	69	69⅞
Philadelphia Electric	19¼	21¼
Western Union	83	83
Westinghouse	73	74
Westinghouse, pf.	117	117

*Last price quoted.

Personal

Dr. William Marconi has been honored by King Alfonso of Spain, who recently conferred on him the Grand Cross of the Order of Alfonso XII.

Mr. S. E. Church, electrical engineer for Sears, Roebuck & Company, will address the Electric Club of Chicago on June 20, his subject being "Illumination."

Mr. M. G. Stratton, formerly of the Bay State Railway Company, Boston, has been appointed manager of the Northumberland County Gas & Electric Company, Sunbury, Pa.

Mr. Robert Lundell will sail on the steamer America on June 13 for his annual trip to Germany and Sweden. Most of the summer will be spent at his estate in Sweden. He expects to return to this country on Sept. 23.

Mr. A. H. Honegger, formerly engineer for the Falkenau Electrical Construction Company, Chicago, has sailed for Warsaw, Russia, where he will represent the electrical department of the International Harvester Company.

Dr. Schuyler Skaats Wheeler, past-president of the American Institute of Electrical Engineers, has had the honorary degree of Master of Science conferred on him by Columbia University, from which he was graduated in 1883.

Mr. James Blaine Walker, assistant secretary of the Public Service Commission for the First New York District, sailed for London June 6 on the *Victoria Louise* of the Hamburg-American Line. He will be gone for about six weeks.

Mr. George V. S. Williams, the recently appointed member of the Public Service Commission for the First New York District, was the guest of honor at a dinner given this week by Mr. William R. Willcox, chairman of the commission.

Mr. E. H. Shufro, for several years purchasing agent for the Union Electric Light & Power Company, of St. Louis, has resigned from that company to engage in other business. Mr. Shufro expects to make his future headquarters in New York.

Mr. E. J. Field, who has been associated with the Pacific Light & Power Corporation at San Bernardino, Cal., for the past eight years, has resigned his position to organize the Southern California Wiring & Fixture Company, with headquarters at San Bernardino.

Mr. John T. Huntington has resigned as general manager of the Green Bay (Wis.) Gas & Electric Company, which controls the Northern Hydro-Electric Power Company, having headquarters at Green Bay, Wis. No announcement has as yet been made concerning his plans.

Mr. J. E. MacDonald, secretary of the joint-pole committee, Los Angeles, presented at the Los Angeles Section of the American Institute of Electrical Engineers his paper on "Practical Joint-Pole Construction," which had been read at the Pacific Coast meeting of the Institute, at Portland, Ore., on April 18.

Mr. W. C. De Vane has resigned his position as superintendent of the Savannah (Ga.) Electric Company, which is a consolidation of the Edison Electric Illuminating Company of Savannah, the Savannah, Thunderbolt & Isle of Hope Railway and the City & Suburban Railway, to enter business for himself.

Mr. H. C. Foss, until recently manager of the Cape Breton Electric Company, Ltd., Sydney, N. S., has been appointed general superintendent of the Savannah (Ga.) Electric Company, to succeed **Mr. E. T. Steel,** who resigned to become secretary to Mr. Frederick F. Pratt, vice-president of the Stone & Webster Management Association.

Mr. Russel Young, superintendent of electrical construction of the British Columbia Electric Railway Company, which operates railway and lighting stations in Vancouver and Victoria, B. C., was married on May 28 to Miss M. L. Wilie, at St. Catharines, Ontario. The couple will spend their honeymoon at Niagara Falls, Schenectady and other points of electrical interest.

Mr. A. C. Dunham, who recently retired from the presidency of the Hartford (Conn.) Electric Company, has presented to Yale University a gift of $75,000 to be applied toward the construction of a laboratory of electrical engineering for the Sheffield Scientific School. Mr. Dunham was graduated from Yale with the class of 1854. His gift is to be treated as a memorial to President Noah Porter and Prof. James Hadley, the father of President Hadley.

Mr. William B. Snow, manager of the Municipal Gas & Electric Light Plant of Holyoke, Mass., will resign his office on June 15, after thirty-seven years' service in the lighting industry of Holyoke. Twenty-eight of these years were spent with the Holyoke Water Power Company, and the remainder of the time with the municipal plant when it took over the interests of this company. Mr. Snow has accepted a position as manager of the New Bedford Gas & Edison Light Company, New Bedford, Mass.

Mr. George R. Stetson, president and manager of the New Bedford (Mass.) Gas & Edison Light Company, was the host at a clambake given to about 125 employees of the company, on May 25, the eve of his departure for a six weeks' trip to California. Mr. Stetson, who has been in continuous service of the company for twenty-five years and has reached the age of seventy-five years, will retire from active management of the company during the present year. His successor will be Mr. William B. Snow.

Obituary

Mr. J. M. C. Gillespie, treasurer of the Universal Cable Grip Company, Syracuse, N. Y., died on May 29 as the result of a motor-cycle accident on May 19. For many years Mr. Gillespie was in charge of the cable department of the Bell Telephone Construction Company, with headquarters in Syracuse.

Mr. Robert Francis Cartwright, a pioneer in the passenger-elevator business and for the past ten years associated with the Otis Elevator Company, died on June 5 at his home in New York City. Mr. Cartwright was one of the organizers, in 1860, of the MacAdam & Cartwright Elevator Company. He was a member of the Engineers' Club of New York.

Construction

MONTGOMERY, ALA.—If granted a permanent injunction restraining the Tallassee Falls Mfg. Co. from interfering with its operations on the Tallapoosa River, the Alabama Interstate Pwr. Co. will build a large storage reservoir at Cherokee Bluffs, at a cost of $5,000,000.

TUSKEGEE, ALA.—Bids will be received until June 24 for the construction of a central heating and lighting plant for the Tuskegee Normal and Industrial Institute, at Tuskegee Institute, Ala. The work includes the construction of a power house and coal bunker, 203 ft. x 112 ft., of brick and concrete construction; the installation of water-tube boilers, engines, generators, pumps, electrical transmission system, steam transmission system, series tungsten street-lighting system, motors and transformers. Plans and specifications may be seen at the office of R. R. Taylor, director of industries, Tuskegee Institute, or at the office of Walter G. Franz, consulting engineer, 1703 Union Trust Building, Cincinnati, Ohio. Plans and specifications may be obtained from the engineer upon a deposit of $25.

KINGMAN, ARIZ.—The Desert Pwr. & Wtr. Co. contemplates extending its north and west lines further into the mining regions. F. A. Wilde is president of the company.

WILLIAMS, ARIZ.—The Grand Canyon El. Lt. & Pwr. Co. is building a new plant to replace the one recently destroyed by fire. Contracts have been placed for machinery and equipment.

BERRYVILLE, ARK.—Plans are being considered by the North Arkansas Pwr. Co. for the construction of a hydroelectric plant on the Kings River, near Berryville, to cost about $250,000. The work includes the construction of a dam 30 ft. high and 300 ft. long, power station and 30 miles of transmission lines. I. R. Packard is engineer in charge.

ELDORADO, ARK.—The plant of the El Dorado Lt. & Wtr. Co. was destroyed by fire recently, causing a loss of about $25,000. The company will not be able to supply electricity for lamps for at least 30 days.

JONESBORO, ARK.—The Business Men's Club has taken steps toward the installation of an ornamental street-lighting system in the business district.

ALAMEDA, CAL.—Bids will be received by F. E. Browning, clerk of the City Council, until June 18, for the construction of lamp-posts, conduits and wiring on Encinal Avenue from Sherman Street to Park Street, and on Central Avenue from Sherman Street to Benton Street. Plans and specifications are on file at the office of the clerk.

BANNING, CAL.—The Consol. Reservoir & Pwr. Co. expects to finish its canal from White River to Banning Valley this summer. Upon the completion of the irrigation canal work will begin on construction of a power plant to supply electricity in Banning, Beaumont and other cities.

BRAWLEY, CAL.—Preparations are being made for the construction of an electric railway to connect Perris, El Centro, Riverside and San Bernardino, and ultimately extend to the Gulf of California. The G. B. Caulin Co., of Los Angeles and San Francisco, will build the line.

CHICO, CAL.—The Northern El. Ry. Co. has applied to the Railroad Commission for permission to issue $1,100,000 in bonds, the proceeds to be used for the construction of an electric railway from Marysville through Colusa to Meridian and to bridge the Sacramento River in Meridian.

CRESCENT CITY, CAL.—The construction of a power plant on the Smith River, near Crescent City, is contemplated by the Mountain Pwr. Co. H. E. Green and E. M. Gilbert are consulting engineers.

KING CITY, CAL.—The State Railroad Commission has granted the Sierra & San Francisco Pwr. Co. permission to purchase the property of the King City Wtr., Lt. & Pwr. Co., at $41,200.

LOS ANGELES, CAL.—Bids are being received for the city by H. B. Ferris for the installation of cables and conduits on Third Avenue between Pico Street and Country Club Drive.

LOS ANGELES, CAL.—The Sycamore Gravel Pit Co. is planning to equip its gravel pit and screening plant with an electric power drag scraper. W. H. Allen, 4500 Pasadena Avenue, Los Angeles, is proprietor.

MONROVIA, CAL.—Plans are being considered by the City Council for the installation of 100 tungsten street lamps.

OROVILLE, CAL.—The Oro Elec. Corpn. has applied to the State Railroad Commission for a certificate of public convenience and necessity for the erection of a transmission and distributing line from its valley plants to San Francisco Bay. The company states that it proposes to serve portions of Plumas, Butte, Yuba, Sutter, Colusa, Yolo, Solano, Sacramento, San Joaquin, Calaveras, Contra Costa and Alameda Counties. A large portion of the right-of-way has already been secured.

PETALUMA, CAL.—The Petaluma & Santa Rosa Ry. Co. has taken over the interest of A. D. Bowen in the proposed new electric railway from a point near this city to the Two Rock Valley. The ranchers have already subscribed $25,000 as a bonus for the construction of the railway. Later it will be extended to Bloomfield and Tomales, then probably to the coast.

PUEBLO, CAL.—The Arkansas Valley Ry., Lt. & Pwr. Co. is extending its transmission line from Concrete to a point on Turkey Creek. It is proposed to tie the different plants together and in case of breakdown at one point power can be secured from another.

SAN FRANCISCO, CAL.—The San José Terminal Ry. Co. is planning to build a combination steamship-electric line between San Francisco and San José, to cost about $1,300,000.

SAN FRANCISCO, CAL.—The Oakland, Antioch & Eastern Ry. Co. has awarded the contract for the construction of its Bay Point-Sacramento line to J. G. White & Co., New York, N. Y., construction engineers. The cost of the road is estimated at $3,000,000.

SAN FRANCISCO, CAL.—The Pacific Gas & El. Co. is planning a 100-mile extension to its hydroelectric distributing system. It is proposed to erect a steel-tower transmission line from the North Tower at Carquinez Straits extending in a northerly direction to Nicolaus in the Sacramento Valley. F. G. Baum is consulting engineer, and P. M. Downing engineer of operation and maintenance.

SAN FRANCISCO, CAL.—An appropriation of $12,500 for clearing away the sites for three dams in the Hetch-Hetchy and Lake Eleanor districts is included in the budget for the coming fiscal year by the finance committee of the Board of Supervisors. This money will be used also to make surveys of the district to determine the possibility of establishing a power house to generate electricity for operating drills for the main work.

SANTA BARBARA, CAL.—The Santa Barbara Consol. Ry. Co. has been granted a long-term franchise and will rehabilitate and make extensions to its system, involving an expenditure of about $200,000.

SOUTH PASADENA, CAL.—The Home Tel. Co. is planning to install a separate exchange for this city.

STOCKTON, CAL.—Estimates of the cost of the proposed electrolier lighting system have been submitted by Prof. C. L. Cory, consulting engineer, of San Francisco. The cost of the underground conduit for the system is estimated at $115,768, and for 551 electroliers, carrying five-lamp clusters, is $96,820, making the total cost $213,588. Prof. Cory in his report calls attention to the inverted series luminous arc-lamp system, which if used would require but 275 lamp-posts, instead of 551, and would cost but $60,500.

COLORADO SPRINGS, COL.—Business men are considering the advisability of organizing an electric-light company, to be capitalized at $1,000,000, to compete with the Colorado Springs Lt., Ht. & Pwr. Co.

COLORADO SPRINGS, COL.—The management of the Modern Woodmen Sanatorium has abandoned its plan of building a power plant and has signed a contract with the Colorado Springs Lt., Ht. & Pwr. Co. for electricity. Work will begin at once on the erection of the 5 miles of high-tension transmission line to transmit the current from the plant north of the city to the sanatorium. A number of transformers will be installed at the grounds to step down the voltage.

DANIELSON, CONN.—The stockholders of the Nashawaug El. Pwr. Co. have voted to purchase the property of the People's Lt. & Pwr. Co. and consolidate the two companies under the name of the Danielson & Plainfield Gas & El. Co. When plans have been perfected all electrical energy will be generated and distributed from the Plainfield plant. The local plant will distribute electricity consumed in this territory. A new 500-kw generator, switchboard, transformers, etc., will be installed in the Plainfield plant. The stockholders of the People's Gas & Power Co. have voted to increase its capital stock from $60,000 to $80,000.

EAST HAMPTON, CONN.—The Public Utilities Commission has ordered the East Haddam El. Lt. Co. to rebuild its plant. The commission recommends the replacement of the present 133-cycle generator, all transformers and other equipment of the 133-cycle type with 60-cycle two-phase or three-phase equipment, so that the company may supply electricity for power as well as for lamps.

GUANTANAMO, CUBA.—Bids will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until June 22 for furnishing and installing a 25,000-gal. quadruple-effect sea-water distilling plant, with all its appurtenances, in connection with the central power plant at the naval station, Guantanamo, Cuba. H. R. Stamford is chief of bureau.

WASHINGTON, D. C.—The contract for construction of a power house for the House of the Good Shepherd has been awarded to the P. F. Gormley Co., Washington, D. C.

WASHINGTON, D. C.—Bids will be received by Major H. L. Pettus, depot quartermaster, U. S. A., Washington, D. C., until June 11, for furnishing 350 CF-12 fixtures in accordance with general specifications No. 5.

WASHINGTON, D. C.—Sealed proposals will be received by Captain R. J. Burt, disbursing officer, Signal Corps, U. S. A., until June 10 for furnishing 23,000 ft. 10-pair paper-insulated, lead-sheathed cable and 28,000 ft. paper-insulated, lead-sheathed and armored cable.

WASHINGTON, D. C.—The Commissioners of the District of Columbia have decided to improve the lighting system around the Capitol grounds, at a cost of about $7,000. It is proposed to replace the inclosed arc lamps and mantle gas lamps now in use with 100-cp electric incandescent lamps.

WASHINGTON, D. C.—Bids will be received until June 18 at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing at the navy yard, Washington, the following supplies: Schedule 4599—one direct-current electric locomotive, one steam duplex air compressor, one vertical feed-water heater, two centrifugal machines, etc. Applications for proposals should designate the schedule desired by number. T. J. Cowie is paymaster-general.

WAUCHULA, FLA.—The Wauchula Mfg. Co. has completed plans for the construction of a new factory to replace the one recently burned. The plans include the installation of an electric-light plant. The company proposes to supply electricity to light the town.

BLACKSHEAR, GA.—At an election to be held June 25 the proposition to issue $10,000 in bonds for the construction of an electric-light plant will be submitted to a vote.

GEORGETOWN, GA.—The town of Georgetown is reported to be contemplating the purchase of the old municipal electric-light plant of the city of Eufaula, which is now building a new plant.

MACON, GA.—Work will begin at once on the construction of the plant of the Macon Cabinet Works to replace the one recently destroyed by fire. The factory will be located on the site of the old one and will be equipped for electrical operation throughout.

NAMPA, IDAHO.—The Boise Interurban El. Ry. Co. has awarded the contract for the construction of a substation and depot in Nampa to Story & Murphy, of Boise.

CARBON CLIFF, ILL.—The Village Board has granted the People's Pwr. Co., Moline, Ill., a franchise to install and operate an electric-light system here. A contract was also awarded for street lighting for a term of five years, under which the company is to furnish 30 tungsten lamps.

CHICAGO, ILL.—It is reported that the Commonwealth Edison Co. is planning to build a large power plant on the Calumet River to supply electricity in connection with equipping the railroads entering Chicago from the south for electrical operation. The plant is to occupy a tract of 22 acres on the east side of the river between Ninety-eighth and One Hundredth Streets.

HAVANA, ILL.—The Public Service Co. of Northern Illinois has made arrangements to erect a new plant here.

LINCOLN, ILL.—The Board of Local Improvements has decided to install conduits for cluster lamps along Lincoln Avenue Boulevard.

MORRISON, ILL.—The property of the Morrison Gas & El. Co. has been transferred to the Northern Illinois Public Utilities Co. The new owners have secured the right-of-way for the high-tension transmission line from Sterling to Morrison.

SANDOVAL, ILL.—The Centralia Gas & El. Co., Centralia, has been granted a 30-year franchise in Sandoval.

WAUKEGAN, ILL.—Preparations are being made by the Public Service Co. of Northern Illinois for the erection of a large addition to its plant here. The addition to the power house will be 50 ft. x 100 ft.

ANGOLA, IND.—The Angola Lt. & Pwr. Co. has taken over the properties operated by the Angola Ry. & Pwr. Co., which has been in the hands of receivers for some time, and which include the electric light, power and water utilities of Angola and also a traction line between Angola and Lake James and Crooked Lake. The new company is capitalized at $94,750 and will make improvements to the system and extend the railway.

ODON, IND.—The local electric-light plant, owned by Gastineau & Howett, of Odon, is reported to have been purchased by Jasper N. Thompson, of Linton, Ind. Preparations are being made for the erection of a new building and plant.

SEYMOUR, IND.—The controlling interest of the Seymour Mutual Tel. Co. has been purchased by T. P. Dickinson, W. P. Smith and L. G. Griffith. The new owners propose to improve the system and extend the lines throughout the country.

BOONE, IA.—Arrangements are being made by the Boone El. Co. for extending its transmission lines to supply electrical service in Madrid, Luther, Woodward, Slater, Ogden, Bouton, Ames, Nevada and other nearby communities.

BURLINGTON, IA.—The Burlington Ry. & Lt. Co. has filed an amendment to its charter increasing its capital stock to $2,500,000.

DAVENPORT, IA.—Application has been made to the Board of County Commissioners by Joseph F. Porter for a 20-year franchise to erect and maintain transmission lines for the distribution of electricity for lamps, heat and motors.

DOWS, IA.—At an election held recently the citizens voted to grant an electric-light franchise to the Segar Engine Works. W. H. Kummel is town clerk.

DUBUQUE, IA.—The Union El. Co. has applied to the City Council for a 25-year franchise for an extension of the street-car line from Rhomberg Avenue on Seventh Street into Eagle Park. The cost of the extension is estimated at about $20,000.

FAIRVIEW, IA.—The Sioux Valley Pwr. Co. is planning to construct a large power plant here this summer. The cost of the work is estimated at $100,000 and will include a 16-ft. concrete dam on the Big Sioux River.

GLADBROOK, IA.—J. P. Walters, of Toledo, secretary of the Toledo El. Pwr., Ry. & Lt. Co., has been granted a franchise to operate an electric-light and power plant here for a period of 25 years.

HOPKINTON, IA.—The proposition to grant an electric-light franchise to W. A. Milroy will soon be submitted to a vote.

MADRID, IA.—The Madrid El. Lt. & Pwr. Co. has been granted a 25-year extension to its franchise, in return for which the company promises to make extensive improvements to its system. A. R. Westerburg is manager of the company.

MARSHALLTOWN, IA.—W. G. Dows and John A. Reed, representing Cedar Rapids capitalists, have been granted a franchise to construct and operate gas, electric and street railways systems here. They will exercise an option on the property of the Marshalltown Lt., Pwr. & Ry. Co.

MUSCATINE, IA.—The installation of an ornamental street-lighting system in the business district is under consideration. It is proposed to install ornamental lamp standards, carrying five-lamp clusters.

OAKLAND, IA.—The installation of a cluster-lamp lighting system is under consideration.

OELWEIN, IA.—Extensive improvements are contemplated by the Oelwein Lt., Ht. & Pwr. Co. to its local system.

PRESCOTT, IA.—The Lee El. Co., Clarinda, has been granted a franchise to supply electricity here.

WALCOTT, IA.—The Tri-City Lt. & Pwr. Co., Davenport, Ia., has applied to the City Council for a franchise to supply electricity in Walcott.

WATERLOO, IA.—The Citizens' Gas & El. Co. is planning to erect two substations, one to be erected in this city and the other in East Waterloo. The cost of the two buildings is estimated at about $10,000.

FORT SCOTT, KAN.—A petition has been presented to the City Council by F. C. Louderback and F. D. Martin providing for the establishment of an electric plant, giving the city the option to take over the plant at the end of six, ten or twelve years. It is proposed to organize a company with a capital stock of $20,000, half of which has already been subscribed.

OSAWATOMIE, KAN.—Contracts for the construction of the municipal electric-light plant have been awarded to Fairbanks, Morse & Co. and to W. T. Osborn Electrical Co., Kansas City, Mo., for $17,900.

SALINA, KAN.—Negotiations have been closed whereby Guy P. Gannett, J. F. Springfield and Walter Grundy, stockholders of the United Wtr., Gas & El. Co., Hutchinson, have purchased the property of the Salina Lt., Pwr. & Gas Co.

TOPEKA, KAN.—The City Commissioners have authorized H. P. Miller, commissioner of light, to engage an electrical engineer to assist the city engineer and superintendent of the electric-light plant to prepare plans for extension of the ornamental lighting system.

VALLEY FALLS, KAN.—The local electric plant has been purchased by W. A. Spencer, of Holton. Improvements will be made to the plant, including the installation of a new boiler and generator. It is also proposed to establish a day service.

WILLIAMSBURG, KAN.—At an election held recently the citizens voted to issue $5,000 in bonds for the installation of water and light plants.

CADIZ, KY.—Plans are being prepared by Alexander Brothers, Cadiz, who have a franchise to install an electric-light system here, to install a plant in connection with an ice factory which they are now building.

CADIZ, KY.—Arrangements are being made by A. P. White & Co., Cadiz, who are constructing a large flour mill, with L. S. Ragsdale for the installation of an electric-light system. Energy for operating the system will be supplied from the power plant of the flour mill.

GREENSBURG, KY.—The Moss Milling Co. has been granted a franchise to operate an electric-light system here.

LOUISVILLE, KY.—The property of the George G. Fetter Ltg. & Htg. Co., Louisville, has been purchased by H. M. Byllesby & Co., Chicago, Ill. It is understood that the plant, located at Bullitt and Water Streets, will be kept in operation. The small electric-lighting plant operated by Pike Campbell in the business district has been purchased by the Byllesby company for $50,000.

MOUNT STERLING, KY.—The Mount Sterling Wtr., Lt. & Ice Co. is planning extensions to its water and light systems.

ROCKLAND, MAINE.—The Central Maine Pwr. Co. has entered into a contract with the Rockland, Thomaston & Camden St. Ry. Co. to supply electricity to the railway company to operate its railways and for lamps, heat and motors for a period of 20 years. The new transmission line will begin at Waterville and extend to Cooper's Mills in Windsor, where it will be joined by a similar line from Augusta. From Cooper's Mills a single high-tension line will carry the power to Rockland.

VEAZIE, MAINE.—The Bangor Pwr. Co., Bangor, is planning to complete its hydroelectric development at Veazie and will construct a reinforced dam 750 ft. long, developing about 33,000 hp. The company is a subsidiary of the Bangor Ry. & El. Co., which operates 65 miles of traction line and supplies electricity for lamps and motors in Bangor, Ellsworth, Mount Desert and several other towns.

BALTIMORE, MD.—Application has been made to the City Council by William J. Martin for a franchise to supply electricity for lamps and motors in Baltimore for a period of 25 years.

BALTIMORE, MD.—Sealed proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until June 17, for two new engines, generators, etc., for the United States post office and court house, Baltimore, Md., in accordance with specifications and drawings, copies of which may be obtained at the above office. James Knox Taylor is supervising architect.

BOSTON, MASS.—Governor Foss has signed the bill authorizing the Boston & Providence R. R. Corpn. to issue $8,000,000 in bonds for the purpose of equipping its main line for electrical operation, eliminating

grade crossings and for additional tracks. The railroad is leased to the New York, New Haven & Hartford R. R. Co.

CHICOPEE, MASS.—The Amherst Pwr. Co. has been granted an entrance into this city. The company will erect a double steel-tower transmission line from Turner's Falls to Amherst this summer and will also build a large substation with garage in Chicopee.

NEW BEDFORD, MASS.—Plans have been prepared by Westinghouse, Church, Kerr & Co., New York, N. Y., for the erection of a new electric distributing station for the New Bedford Gas & El. Lt. Co., to be erected at Spring and Fourth Streets. The proposed building will be 100 ft. x 150 ft., brick and steel construction, and will cost about $75,000.

PRINCETON, MASS.—A special town meeting will soon be called to vote on the proposition to install a municipal electric-light plant to furnish electricity to light the villages of Princeton, East Princeton and Bucks.

WILLIAMSBURG, MASS.—The Selectmen have granted the Northampton El. Ltg. Co. a franchise in Williamsburg.

BARRYTOWN, MICH.—The dam of the Barrytown El. Lt. & Pwr. Co. was recently carried away by the flood.

IRON MOUNTAIN, MICH.—The Peninsula Pwr. Co., which is developing a water-power at the Twin Falls of the Menominee River, near Iron Mountain, has started to furnish electricity to the mines in the Iron River district. Pending the completion of the large hydroelectric plant on the river and the erection of 40 miles of transmission lines to the western end of the Menominee district, the Iron River subdivision is served by a steam plant, which afterward will be retained for use in emergencies.

ISHPEMING, MICH.—Plans have been adopted by the City Council for improving the street-lighting system and the erection of 22 ornamental lamp standards, carrying five-lamp clusters, on Main Street. Under the new contract some of the arc lamps now in use will be replaced with 100-watt Mazda lamps. The Marquette County Gas & El. Co. furnishes the street-lighting service.

OLIVET, MICH.—At a special election held recently the proposition to grant the Commonwealth Pwr. Co. a franchise was carried. Work will start at once on the erection of a transmission line from Charlotte to Olivet. Work has already begun on the large towers from Battle Creek to Charlotte. When the lines are completed the farmers along the lines will also be supplied with electricity.

WYOMING, MICH.—Another special election will soon be held in Wyoming Township to vote on the proposition to grant the Grand Rapids-Muskegon Pwr. Co. a franchise to supply electricity here. Wyoming has not a post office.

DULUTH, MINN.—Extensive improvements are contemplated by the Zenith Tel. Co., including the construction of a new exchange building and extension of the system to the Lakeside district. The cost of the work is estimated at $178,000.

ELY, MINN.—Citizens residing in the Zenith location have presented a petition to the City Council asking that the municipal electric-light service be extended to that section of the city.

LAKEFIELD, MINN.—Bids will be received by R. J. Hill, city clerk, until June 11 for one direct-current generator, three-wire, compound-wound, and one direct-current generator, two-wire, compound-wound, 250 volts.

LESUEUR CENTER, MINN.—The Village Council has granted James P. Porteus a franchise to erect and maintain an electric-light plant here.

McINTOSH, MINN.—Steps have been taken by the business men to install an ornamental street-lighting system in the business district. Julius Halvorson is at the head of the movement.

MINNEAPOLIS, MINN.—The Consumers' Pwr. Co. has filed amendments to its charter increasing its capital stock from $10,000,000 to $17,500,000 and removing its headquarters to Minneapolis.

MOORHEAD, MINN.—The City Council is considering the question of extending the water and light systems to Swede Town, on the outskirts of the city limits.

RUSHMORE, MINN.—The Fulda Tel. Co. has purchased the property of the Farmers' Mutual Tel. Co. About $10,000 will be expended for improvements to the system by the new owners.

VIRGINIA, MINN.—The power station of the Mesaba El. Ry. Co. will be located on the property of the Virginia & Rainy Lake Co., across Suver Lake from the end of Chestnut Street. Work will soon begin on construction of plant.

BETHANY, MO.—At an election held May 28 the proposition to issue $25,000 in bonds for the erection of a new municipal electric-light and water plant was carried. J. B. McClure is city clerk.

CRAIG, MO.—It is reported that arrangements are being made to consolidate the Craig and Mound City electric plants in order to secure electricity to operate the two new grain elevators and flouring mills being erected here.

KANSAS CITY, MO.—The Kansas City, Clay County & St. Joseph Ry. Co. will award contracts at once for the erection of three substations, two of which will be located on the St. Joseph branch, one 12 miles from Kansas City and the other at Willowbrook; the third will be erected on the Excelsior Springs line, about 4 miles east of Liberty.

ST. JOSEPH, MO.—The St. Joseph St. Ry., Lt., Ht. & Pwr. Co. is planning to make extensive additions and improvements to its power plant on Felix Street, to cost about $100,000. The work will include the installation of a 4000-hp horizontal turbine generator and two new boilers. An addition will also be built to the power house.

ST. LOUIS, MO.—The Lt. & Devel. Co. of St. Louis has increased its capital stock to $1,000,000. W. A. Smith, Wright Building, St. Louis, is vice-president.

MILES CITY, MONT.—The Council has voted to engage an electrical engineer to make an appraisal of the municipal electric-light plant with a view of selling it to the Lower Yellowstone Pwr. Co.

NORFOLK, NEB.—The Norfolk Lt. & Pwr. Co. is contemplating erecting a high-tension transmission line from Norfolk to Tilden.

PORTSMOUTH, N. H.—The Rockingham County Lt. & Power Co. is extending its transmission lines from Little Boar's Head to the North Hampton railroad station and from the Cable Road at Jenness Beach to Rye Center.

FORT HANCOCK, N. J.—Sealed proposals will be received at the office of the quartermaster, Fort Hancock, N. J., until June 15, for installing an electric-lighting system and apparatus in power plant. Further information furnished on application to above office.

ARTESIA, N. M.—The property of the Artesia El. Lt. & Pwr. Co. has been purchased by John C. Keyes, of Oklahoma City, Okla. The new owner proposes to enlarge the plant and erect transmission lines into the farming districts in this section.

ALEXANDRIA BAY, N. Y.—The village officials have granted a 50-year franchise to Ozro Phillips, Lowville, and George Phillips, Philadelphia, to erect transmission lines for distribution of electricity in and through this village.

LOCK BERLIN, N. Y.—The residents of this village are circulating a petition for presentation to the Town Board of Galen asking that a lighting district be formed. If granted, application will be made to the Rochester, Syracuse & Eastern R. R. Co. to supply electricity for lighting the streets and residences.

NEW YORK, N. Y.—Sealed bids will be received by C. B. J. Snyder, superintendent of school buildings, Department of Education, Park Avenue and Fifty-ninth Street, New York, N. Y., until June 17, for alterations and additions to the electric equipment in Public Schools 1, 19, 25, 36 and 106 and Truant School, Borough of Manhattan. Blank forms, plans and specifications may be obtained at the office of the superintendent.

NEW YORK, N. Y.—The Public Service Commission has authorized the New York Tel. Co. to issue $5,000,000 in bonds, the proceeds to be used for proposed improvements, including the completion of the Seneca and Tupper central office building in Buffalo and the West Thirty-seventh Street central building in this city. The company is contemplating an issue of $25,000,000 in bonds, the proceeds of $20,000,000 to be used for the purchase of Bell telephone plants and property located in Virginia and West Virginia and for construction of and improvements to the system outside of New York State.

NIAGARA FALLS, N. Y.—Application has been made to the Public Service Commission by the Niagara Falls Pwr. Co. for permission to issue $3,567,000 in bonds or stock, the proceeds to be used for improvements to its system, including construction projects of the Canadian Niagara Pwr. Co.

ONTARIO, N. Y.—Preparations are being made by the Sodus Gas & El. Lt. Co. to light the streets of the village. It is proposed to use 32-cp incandescent lamps.

RIVERHEAD, N. Y.—The Riverhead El. Lt. Co. has sold its Westhampton Beach system, including franchises, poles, wires, etc., to the Southampton Lt. Co. The Southampton company will soon begin operations in Good Ground and is now operating in Speonk and Eastport. It proposes to supply electricity to all the territory from Water Mill to Eastport. It is understood that the company will establish a substation in Good Ground.

SPENCERPORT, N. Y.—The Ogden Town Board has granted the Rochester Ry. & Lt. Co. a franchise to supply electricity for lamps, heat and motors in the town of Ogden. The proposed line will extend up the Ridge Road to Spencerport, from this village into Ogden and thence to Adams Basin.

WATERTOWN, N. Y.—The Watertown Lt. & Pwr. Co. is preparing plans for extensive improvements to its hydroelectric plant on Black River.

WOLCOTT, N. Y.—Sealed bids will be received by the Board of Trustees of the village of Wolcott until June 19 for construction of about 6 miles of cast-iron mains, standpipe, small reservoir, pump-house, two electric-driven power pumps and other accessories. L. W. Knapp is village clerk. Plans and specifications may be seen at the office of the board.

YONKERS, N. Y.—The Merchants' Association has decided to erect 180 ornamental lamp standards, carrying five-lamp clusters, in the business district.

SOUTHPORT, N. C.—The Southport Lt. & Pwr. Co. is planning to build an electric-light plant here. The power house will be 35 ft. x 67 ft. The company is capitalized at $50,000. H. P. O'Hagan is secretary and manager.

NORTHWOOD, N. D.—The citizens have voted to issue bonds for the installation of an electric-light system. The plant will cost about $8,000.

CINCINNATI, OHIO.—The City Council has adopted the recommendation of the committee on light that the Madisonville light plant be continued in operation as a municipal plant for the purpose of supplying electricity for lamps and motors for commercial purposes, as an experiment in municipal ownership. The Union Gas & El. Co. is to furnish the street-lighting service in Madisonville, in accordance with the city blanket contract and annexation agreement.

CLEVELAND, OHIO.—The Lake Shore El. Ry. Co. is contemplating the installation of new equipment in its power plant.

CLEVELAND, OHIO.—Chief Engineer Ballard of the municipal electric-light plant has been authorized to prepare plans and specifications for the electrical equipment to be installed in the old Division pumping station, to cost approximately $35,000.

COLUMBUS, OHIO.—Bids will be received by S. A. Kinnear, director of public service, until June 11 for furnishing material for connecting the cluster lighting system to the municipal electric-light plant.

COLUMBUS, OHIO.—Bids will be received by S. A. Kinnear, director of public service, Columbus, Ohio, until June 11, for furnishing material and connecting the cluster-lighting system to the municipal electric-light plant as follows: (1) 26,200 ft. No. 0 triple-braid W. P. stranded wire; (2) 20,800 ft. No. 6 triple-braid W. P. solid wire; (3) 3200 ft. No. 0 lead-inclosed duplex cable; (4) 510 ft. No. 1 lead-inclosed duplex cable; (5) 1250 ft. No. 2 lead-inclosed duplex cable; (6) 1810 ft. No. 4 lead-inclosed duplex cable; (7) 1150 ft. No. 6 lead-inclosed duplex cable; (9) 70 ft. No. 0 four conductor lead-inclosed cable; (10) 6060 ft. No. 10 duplex steel-taped cable—all for 2500-volt insulation; (8) 300 ft. No. 0 R. C. D. B. cable, 600-volt insulation; (11) two 23-kva feeder regulators, including compensators; (12) 21 manholes, complete with drains installed; (13) 12 outdoor type lightning arresters; (14) 7280 ft. 3-in. conduit, installed; (15) 30 one-lamp standards, including fixtures and globes.

DEFIANCE, OHIO.—The Auglaize Pwr. Co. has purchased the old Hoover dam site, near Cloverdale, just above the mouth of the Blanchard River, where it proposes to erect another hydroelectric power plant, capable of developing 2500 kw. The dam will be 25 ft. high and 300 ft. long. The contract for construction of dam has been awarded to the Ambursen Hydraulic Constr. Co., Boston, Mass.

PORT CLINTON, OHIO.—The American Gypsum Co. has engaged W. S. Ferguson Co., Cleveland, engineers, to prepare plans for the construction of a power plant here, to cost about $50,000.

SALEM, OHIO.—Sealed bids will be received by D. H. Rummel, director of public service, Salem, Ohio, until June 26, for furnishing material and installing an electric-light distributing system for the city of Salem. Plans and specifications may be seen at the above office and also at the office of the Bailey Engineering Co., Alliance, Ohio.

STRUTHERS, OHIO.—The Consol. Gas & El. Co., Youngstown, has applied to the Council for a franchise to erect a transmission line through this village.

YOUNGSTOWN, OHIO.—Work has begun on the construction of a large department store for the G. M. McKelvey Co. A large electric plant and a steam-heating and ventilating system will be installed in the sub-basements.

ZANESVILLE, OHIO.—The City Council has authorized the Public Service Director to employ an engineer to prepare plans and specifications for a new pumping station and power plant and driving wells for supplying the city with water.

LAWTON, OKLA.—The Lawton Ry. & Ltg. Co. has been granted a franchise to construct and operate an electric-light and power plant and street railway system here. The company has recently acquired the property of the Comanche Lt. & Pwr. Co. for a consideration of $125,000 and the holdings of the defunct Lawton & Fort Sill El. Ry. Co. for $25,000. The company proposes to construct an interurban electric railway between Lawton and Fort Sill. L. E. Fisher, of St. Louis, Mo., and E. R. Stephens, McAlester, are principal owners.

OKLAHOMA CITY, OKLA.—Proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until June 18, for an electric passenger elevator for the United States Post Office, Oklahoma City, in accordance with drawings and specifications, copies of which may be obtained at the above office. James Knox Taylor is supervising architect.

MILWAUKEE, ORE.—The City Council has granted the Southern Pacific Co. a franchise to construct an electric railway, telephone and telegraph lines through the city.

PORTLAND, ORE.—The Northwestern El. Co., which has applied to the City Council for a franchise to supply electricity for lamps and motors here, has begun work on the construction of a large hydroelectric power development on the White Salmon River, near Husum, Wash. Work will begin on the erection of the transmission lines from the dam and the distributing system in Portland upon favorable action on its application for franchise. The proposed dam will be 150 ft. high and will cost about $500,000. The contract for construction of the dam has been awarded to the Stone & Webster Engineering Corpn., Boston, Mass., and that for the electrical machinery and equipment to the General El. Co. Franchises will be applied for in other cities and towns in this section. Herbert Fleischhacker, San Francisco, Cal., is vice-president of the company.

STAYTON, ORE.—The City Council has granted a franchise to J. F. Mounce to build an electric railway on three streets in this city. The proposed railway will extend from Salem to Slayton, a distance of about 15 miles.

CONNELLSVILLE, PA.—The main power house of the West Penn Trac. Co. will soon be increased from 42,000 hp to 55,000 hp. This company supplies electricity for lamps and motors in 110 cities and towns in the Pittsburgh district within a radius of from 30 to 60 miles of that city. The company also operates the street-railway system in this district, consisting of 209 miles of track.

HAMBURG, PA.—The Hamburg El. Lt. & Pwr. Co. is extending its transmission lines to Shoemakersville to supply electricity in that town. Electrical service will also be supplied to residents living along the line.

HARRISBURG, PA.—Mayor Royal has signed the ordinance permitting the merger of the Harrisburg Lt., Ht. & Pwr. Co. and the Paxtang El. Co., Harrisburg.

HARRISBURG, PA.—The Council has awarded the contract for street lighting and for furnishing power for the police and fire-alarm systems to the Harrisburg Lt., Ht. & Pwr. Co. for a period of five years.

HARRISBURG, PA.—Three of the recently chartered electric companies in Bucks County have filed notices of increase of capital stock. The Morrisville company has increased from $5,000 to $150,000, the township of Bristol company from $5,000 to $10,000 and the township of Lower Makefield company from $5,000 to $100,000.

PHILADELPHIA, PA.—Sealed proposals will be received at the Philadelphia Depot Quartermaster's Department, Twenty-sixth Street and Gray's Ferry Road, Philadelphia, Pa., until June 15, for remodeling the electric light and power plant and installing boilers. Blank proposals and further information will be furnished upon application to this office. Lieut.-Col. Chauncey B. Baker is constructing quartermaster.

PITTSBURGH, PA.—The capital stock of the American Water Works & Guarantee Co. has been increased from $10,000,000 to $20,000,000. The proceeds will be used to provide funds to finance important extensions to its property, among them being the construction of a large hydroelectric power plant on the Cheat River.

PITTSBURGH, PA.—The contract for the installation of a new street-lighting system on Federal Street, North Side, has been awarded to the Westinghouse El. & Mfg. Co., for $6,997. The company will furnish 90 ornamental lamp standards, 95 3000-cp flaming carbon arc lamps and necessary switchboards, transformers, wires, etc.

PITTSBURGH, PA.—Sealed proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until June 17 for three new engines and generators for the United States court house and post office building, Pittsburgh, Pa. Plans and specifications may be obtained at the above office. James Knox Taylor is supervising architect.

PITTSBURGH, PA.—Proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until June 24 for the installation of a conduit and wiring system and lighting fixtures in the United States court house and post office, Pittsburgh, Pa., in accordance with drawings and specifications, copies of which may be obtained at the above office or at the office of the custodian, Pittsburgh James Knox Taylor is supervising architect.

SHARON, PA.—The proposition to issue $85,000 in bonds for the installation of a municipal electric-light plant was carried at an election held May 28.

SAN JUAN, P. R.—Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until June 22, for the construction of two steel towers at the Naval Radio Station, San Juan, P. R. Plans and specifications may be obtained on application to the bureau. H. R. Stanford is chief of bureau.

WARREN, R. I.—Improvements are contemplated by the Cutler Mills Corporation, including the erection of a new power plant. Upon completion of the new building three new boilers will be installed. John H. Estes is president.

DECHERD, TENN.—Plans are being considered by the Decherd Mill Co. for the installation of an electric-light plant. Natural gas will be used as fuel. C. E. Murray is engineer in charge.

GLEASON, TENN.—Surveys are being made of the Jones mill property with a view to utilizing the water-power to generate electricity for lamps in Gleason and Dresden. It is reported that a movement is on foot to build an electric railway from Fulton, Ky., to Paris, Tenn., and from Gleason to Greenfield and Dyersburg.

MORRISTOWN, TENN.—Plans are being considered by the Commercial Club of Morristown for the establishment of a hydroelectric plant on one of the rivers in this section.

FOWLERTOWN, TEX.—Investigations are being made by G. W. Scheuling, of McMinnville, Tenn., and associates for the installation of an electric-light plant, ice factory and water-works system.

GARRETSON, TEX.—A special election has been called for the purpose of submitting the proposition to issue $6,000 in bonds for the installation of an electric-light plant to a vote.

HOUSTON, TEX.—The Great Houston Suburban Corpn. is planning to install an electric-light plant in the Park Place addition, work on which will soon begin. C. J. McCarty is president.

KERRVILLE, TEX.—The Kerrville electric light and ice plant has been purchased by Thomas Holdsworth for $27,500.

MADISONVILLE, TEX.—The taxpayers are circulating a petition asking the City Council to call an election to submit the proposition to issue $20,000 in bonds for the installation of an electric-light plant and waterworks system to the voters.

SAN ANTONIO, TEX.—The San Antonio Trac. Co. is planning to install a 3000-kw generator and necessary transformers and other machinery in station B of its power plant here.

OGDEN, UTAH.—In order to increase the efficiency of the pioneer plant of the Utah Lt. & Ry. Co. the power dam will be raised in the Ogden Canyon 4 ft. above its present level. This additional fall of water will practically double the output of the plant. New machinery will be installed during the summer.

OLYMPIA, WASH.—The contract for the electrical work on the Temple of Justice has been awarded to Evans-Dickson Co., Tacoma, Wash.

SEATTLE, WASH.—The Council is securing data for the installation of a municipal telephone system. A. L. Valentine, superintendent of city utilities, is in charge of the work.

SPOKANE, WASH.—The International Pwr. & Mfg. Co. is preparing to begin work on the construction of a large hydroelectric power plant on the Pend Oreille River in the northeastern part of Washington. The proposed plant will ultimately develop 100,000 hp.

TONO, WASH.—Work has been started on the proposed electric power plant of the Washington Union Coal Co. in Tono.

MINERAL POINT, WIS.—The Mineral Point Public Service Co. is extending its main transmission line from Linden to the Highland Camp. A line is also being erected from Mineral Point to Rewey, Livingston, Montfort and Highland, and the circuit will be completed by including Cobb and Edmund.

OAKFIELD, WIS.—W. E. Bristol, of the Oakfield Lt. & Pwr. Co., is asking for bids for a complete light and power plant, including power house, a 25-hp to 30-hp oil engine, a 20-kw generator, a 3-kw balancer set, switchboard complete and a storage battery. C. S. Thompson, Oshkosh, Wis., is engineer.

BASSANO, ALTA., CAN.—The time for receiving tenders for furnishing electric generating machinery for the Bassano El. Pwr. & Trac. Co. has been extended from June 3 to June 17. For details see issue of May 25. S. E. Whiting is president of the company, and Bowring & Logan, Winnipeg, Man., are engineers.

McLEOD, ALTA., CAN.—The question of developing the waterpower from waterfalls on the Old Man River to supply this city with electricity is under consideration.

TRAIL, B. C., CAN.—The Consol. Mining & Smelting Co. is planning to make improvements on its smelter in Trail, involving an expenditure of $100,000. The work will include a matte plant, a lead mill and an electric tramway system.

VANCOUVER, B. C., CAN.—The board of the Vancouver General Hospital has applied for a permit for the erection of a building to be used as a power house, to cost about $55,000.

VANCOUVER, B. C., CAN.—The British Columbia El. Ry. Co. has awarded the contract for the construction of its substation at Earl's Road to McPhalen Brothers. The cost of the station is estimated at $125,000.

WINNIPEG, MAN., CAN.—The fire, water and light committee has recommended to the Council the installation of 240 street arc lamps, the cost of which is estimated at about $15,600. J. G. Glasco is electrical superintendent of the municipal electric plant.

NEWCASTLE, N. B., CAN.—John A. Follansbee is interested in a project to construct a dam on Southwest Miramichi River at Grey Rapids, about 2 miles above Indiantown, the power to be utilized to generate electricity to be transmitted throughout the whole Miramichi valley from Boiestown to Escuminac. Charles Quinn, of New York, N. Y., electrical engineer, will make investigations and report to the Ontario capitalists who are interested.

BRANTFORD, ONT., CAN.—The special citizens' committee has decided to recommend the submission of a by-law to expend $115,000 on a distributing plant, to utilize energy from the Hydro-Electric Commission system and reject the proposal to take steps to enforce the Cataract agreement, under which Brantford should receive energy at rates 10 per cent less than where the Hydro-Electric Commission is operating.

TORONTO, ONT., CAN.—Another extension of the Hydro-Electric Commission system in the Midlands district is contemplated on the other side of Lake Simcoe. Application has been made to the Hydro-Electric Commission by the towns of Beaverton, Cannington, Sunderland, Woodville, the township of Brock and intermediate places. It is proposed to have the commission secure power under the contract with the Simcoe Pwr. Co., developed at Big Chute Falls, on the Severn River.

MOOSE JAW, SASK., CAN.—The power house and machinery of the municipal electric-light plant was recently destroyed by fire, causing a loss of about $500,000.

MOOSE JAW, SASK., CAN.—Tenders will be received by the City Commissioners until June 14 for 50 ornamental lamp standards suitable for tungsten lamps. Plans and further information may be obtained from J. D. Peters, electrical superintendent.

HUALAHUISES, NUEVO LEON, MEX.—Preparations are being made for the installation of a municipal hydroelectric plant on the Hualahuises River to furnish electricity for lamps and for motors for the town.

New Industrial Companies

THE COMMERCIAL ELECTRIC COMPANY, of Spokane, Wash., has been incorporated with a capital stock of $10,000 by E. S. Thurston, J. I. Price and others.

THE PHILADELPHIA GAS & ELECTRIC FIXTURE COMPANY, of New York, N. Y., has filed articles of incorporation with a capital stock of $10,000. The incorporators are: Samuel Augenblick, Louis B. Brodsky, New York, N. Y., and Celia Rothstein, Brooklyn.

THE PNEUMATIC CONDUIT THREADER COMPANY, of Richmond, Va., has been incorporated with a capital stock of $100,000 to manufacture and deal in conduit threaders. The officers are: Charles Gault Harris, president; H. T. Eubank, vice-president, and E. S. Evans, secretary and treasurer.

THE SPROUL EQUIPMENT COMPANY, of Peekskill, N. Y., has been granted a charter with a capital stock of $50,000 for the purpose of engaging in electrical contracting business. The incorporators are: Harvey B. Sproul, Alma J. Sproul and Allan Roraback, all of Peekskill.

THE UTAH ELECTRIC MANUFACTURING COMPANY, of Salt Lake City, Utah, has been organized with a capital stock of $70,000 for the purpose of manufacturing electric hand irons, etc. The officers are: Frank J. Adams, president; J. D. Quinn, vice-president, and Earl Huggard, secretary and treasurer.

THE WEITCH MOTOR MANUFACTURING COMPANY, of New York, N. Y., has been incorporated by J. S. Harris and P. J. McIntosh, New York, N. Y., and C. H. Toy, Brooklyn, N. Y. The company is capitalized at $200,000 and proposes to manufacture motors, machinery, etc.

New Incorporations

GENEVA, ALA.—The Geneva Pwr. Co. has filed articles of incorporation with a capital stock of $8,000 for the purpose of building an electric power plant in Geneva. D. O. Vaughn and others are incorporators.

VISALIA, CAL.—The Big Four El. Ry. Co. has been incorporated with a capital stock of $500,000 by Calvin Russell, Jr., John Hitchcock, of Tulare, and Paul Blankenship, of Woodville. The company proposes to build a 34-mile electric railway from Tulare to Woodville, thence to Poplar and Porterville, and a branch line from Tulare to Visalia.

GOSHEN, IND.—The Goshen Pub. Ser. Co. has been chartered with a capital stock of $10,000 for the purpose of installing and operating an electric light and power plant in Goshen. The directors are: Milton O. Payne, Charles R. Scott and Wilbur L. Stone.

PORTLAND, MAINE.—The Island Lt. & Wtr. Co. has filed articles of incorporation with a capital stock of $50,000 for the purpose of generating and distributing electricity and gas for lighting, heating and for manufacturing purposes on Cushing Island, Little Diamond Island and Great Diamond Island in Casco Bay; also to supply water for drinking and municipal purposes.The officers are: Silas B. Adams, president; Leroy F. Tobie, treasurer, and Scott Wilson, clerk, all of Portland.

ANNAPOLIS, MD.—The Annapolis Public Utilities Corporation has been chartered with a capital stock of $300,000 to build and operate electric light and power and gas plants, etc. The incorporators are: George Winship Taylor and L. Vernon Miller, of Baltimore.

FOLEY, MINN.—The Foley El. Lt. & Pwr. Co. has been granted a charter with a capital stock of $15,000. The incorporators are: H. E. Becker, Helen S. Becker and George A. Becker, all of Minden.

Trade Publications

HOISTS.—The General Electric Company has issued Bulletin No. 4939, which is descriptive of electric hoists manufactured by that company.

VEHICLE MOTORS.—Vehicle motors made by the Diehl Manufacturing Company, Elizabethport, N. J., are dealt with in Bulletin No. 130. Eleven illustrations and a full description are given of this motor.

DIRECT-CURRENT GENERATORS.—Circular No. 1194 issued by the Westinghouse Electric & Manufacturing Company covers direct-current engine-driven generators and describes their construction as well as illustrating the various parts.

BOILER TUBE CLEANERS.—Bulletin U—a four-page folder—has been issued by the Lagonda Manufacturing Company, of Springfield, Ohio. It refers specifically to the new air cleaner which is said to embody the latest improvements in air-driven boiler-tube cleaners.

CRUSHING AND GRINDING MACHINERY.—The Sturtevant Mill Company, Boston, Mass., has issued a sixteen-page booklet illustrating and giving brief descriptions of machinery especially suited for crushing, grinding and screening hard substances such as quartz, granite and ores.

ELECTRICAL SUPPLIES.—The Frank Adam Electric Company, 904-14 Pine Street, St. Louis, Mo., presents a well-got-up catalog of general electrical supplies. Its arrangement in illustrating the article opposite the table of list prices is good. The catalog is bound in cloth to withstand constant handling.

Business Notes

THE MONARCH INCANDESCENT LAMP WORKS of the General Electric Company have moved their offices from 900 Wabash Avenue to 1109 Manhattan Building, Chicago.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., has recently installed over $100,000 worth of additional machinery to augment its manufacturing facilities.

THE ECONOMY FUSE & MANUFACTURING COMPANY, formerly of Pittsburgh, Pa., has just moved its factory and general offices to Kinzie and Orleans Streets, Chicago, Ill.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, is distributing upon request a booklet entitled "Joseph Dixon, One of the World Makers," written by Elbert Hubbard.

THE ALBERGER PUMP & CONDENSER COMPANY has been joined by the consolidation of the Alberger Condenser Company, the Alberger Pump Company and the Newburgh Ice Machine & Engine Company. The main office will be at 140 Cedar Street, New York.

THE WESTERN ELECTRIC COMPANY has increased the clerical and sales forces of its Buffalo office and is also planning to increase the stocks carried there. Mr. L. F. Philo has been appointed sales manager at Buffalo, and the administration has been so arranged that all matters arising in connection with relations between the company and its customers may be handled directly by the Buffalo organization.

NORTHERN ELECTRICAL COMPANY.—A branch has been opened in Minneapolis by the Northern Electrical Company, jobber of electrical supplies and machinery, Duluth, Minn. This new house will conduct a general supply and contracting business, specializing on appliances for the home, the factory and the office. Mr. Fred. G. Dustin, formerly chief electrical inspector of Minneapolis, is manager of the new office.

THE WATSON-STILLMAN COMPANY, 50 Church Street, New York, has announced the election of the following officers: President, Mr. E. A. Stillman; vice-president and secretary, Mr. A. F. Stillman; treasurer, Mr. J. P. Bird; chief engineer, Mr. Carl Wigtel; superintendent, Mr. Frank Lary. A new branch office is to be opened at Philadelphia shortly and shop facilities are being improved to meet increasing business.

LAGONDA MANUFACTURING COMPANY.—Owing to increased business, the Lagonda Manufacturing Company, of Springfield, Ohio, maker of boiler-tube cleaners, cut-off valves, water strainers, etc., is planning to erect a new office building. The present offices of the company, now located in one end of the factory building, occupy space needed for manufacturing purposes. The new building will be of reinforced concrete and will be equipped with modern office labor-saving devices.

THE STERLING ELECTRIC COMPANY, Minneapolis, which lays claim to the distinction of being the largest electrical supply house west of Chicago, has moved into its new building at 31 South Fifth Street. The history of this company is of some interest. Seven years ago the Northern Electrical Company entered the electrical contracting and supply business at 329 Hennepin Avenue, Minneapolis. The business increased rapidly and soon larger headquarters were secured at 9 South Fifth Street. By consolidation the business of the Minneapolis Electric Motor Company was secured, and in 1907 the name of that company was adopted by the Northern company. On Jan. 1, 1912, there was another change in name, the title Sterling Electric Company being chosen.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MAY 28, 1912.

[Prepared by Robert Starr Allyn, 16 Exchange Place, New York.]

1,027,404. TERMINAL INSULATOR IN JUNCTION BOXES OR THE LIKE; R. Deibel, Charlottenburg, Germany. App. filed April 29, 1909. Water and oil-sealed joint.

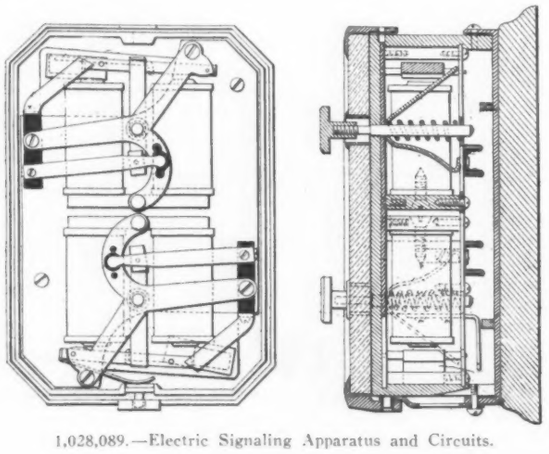
1,027,415. MOTOR-CONTROL SYSTEM; A. M. Gray, Milwaukee, Wis. App. filed Oct. 5, 1910. Alternating-current induction motor with high power-factor and large overload capacity.

1,027,422. INDUCTION SYNCHRONOUS MOTOR; C. H. Kicklighter, Newberry, S. C. App. filed Sept. 10, 1908. Convertible type with sliding magnetic connectors.

1,027,440. TIME-ELEMENT DEVICE; G. B. Schley, Milwaukee, Wis. App. filed July 28, 1911. Electromagnetically retarded rotatable disk.

1,027,485. TELEPHONE SYSTEM; O. M. Leich, Genoa, Ill. App. filed March 27, 1911. Intercommunicating local-battery exchange and common-battery central.

1,027,494. TELEPHONE RECEIVER; S. G. McMeen, San Francisco, Cal. App. filed April 28, 1910. A condenser is retained by the end cap.



1,028,089.—Electric Signaling Apparatus and Circuits.

1,027,495. ELECTROLYTIC PROCESS; R. I. McNitt, Niagara Falls, N. Y. App. filed Sept. 25, 1909. The electrode substance is cooled by circulation.

1,027,550. INDUCTION MAGNETO; R. C. Lanphier, Springfield, Ill. App. filed Oct. 9, 1909. No moving wires or contacts.

1,027,601. INSULATOR AND SUPPORT; L. F. Gressett, Ballinger, Tex. App. filed April 24, 1911. A drivable pin with insulating bushing.

1,027,658. TALKING-MOVING-PICTURE MECHANISM; O. E. Kellum, Los Angeles, Cal. App. filed June 28, 1911. Synchronizing mechanism.

1,027,666. ELECTRIC SADIRON TERMINAL BOX; L. F. Parkhurst, Binghamton, N. Y. App. filed Feb. 15, 1911. Electrical connections.

1,027,679. ELECTRICALLY PROTECTED GRILLE WORK OR GRATING; J. P. Williams and H. Huhn, New York, N. Y. App. filed Dec. 8, 1910. Bars made of concentric tubes and rods.

1,027,684. ELECTRICAL MEASURING INSTRUMENT; W. E. Beede, New York, N. Y. App. filed March 22, 1911. Galvanometer of D'Arsonval type with bridging and damping devices.

1,027,700. ELECTRIC-LIGHTING SYSTEM FOR SELF-PROPELLED VEHICLES; J. K. Delano, Jr., Chicago, Ill. App. filed May 19, 1910. Combined motor-driven and storage-battery system.

1,027,708. METALLIC CROSS-ARM FOR POLES; C. G. Ette, St. Louis, Mo. App. filed May 25, 1911. Channel crosspiece with vertical and drop pins.

1,027,709. POLE CROSS-ARM; C. G. Ette, St. Louis, Mo. App. filed Sept. 18, 1911. Channel crosspiece with offset insulator pins.

1,027,710. POLE CROSS ARM; C. G. Ette, St. Louis, Mo. App. filed Sept. 30, 1911. Channel crosspiece with locked insulator pins.

1,027,711. POLE CROSS-ARM; C. G. Ette, St. Louis, Mo. App. filed Nov. 22, 1911. Channel cross-arm with two sets of insulator pins.

1,027,712. INSULATOR-SUPPORTING DEVICE; C. G. Ette, St. Louis, Mo. App. filed Dec. 18, 1911. Device for clamping to a cross-arm.

1,027,739. ELECTRIC OVEN OR COOKER; C. A. Lauzon, Grand Rapids, Mich. App. filed Sept. 30, 1910. Has a detachable heater plate.

1,027,755. AMPLIFIER; G. W. Pickard, Amesbury, Mass. App. filed Aug. 7, 1907. Wireless telegraphy detector with variable resistance liquids.

1,027,756. COOLING DEVICE FOR TROLLEY WHEELS; H. Prack, Ottawa, Ill. App. filed Aug. 26, 1911. Air-cooling device.

1,027,763. FLEXIBLE ELECTRIC HEATER; L. C. Rhea, Columbus, Ohio. App. filed Nov. 19, 1909. Blanket or pad.

1,027,795. VACUUM REGULATOR FOR X-RAY TUBES; B. E. Baker, Hartford, Conn. App. filed June 9, 1911. Has an auxiliary cathode and a gas-producing element.

1,027,796. MOTOR CONTROLLER; T. E. Barnum, Milwaukee, Wis. App. filed July 25, 1910. For periodically reversing motors; for instance, for washing machines.

1,027,831. WATER HEATER; W. H. Fox, Minneapolis, Minn. App. filed Nov. 5, 1910. Water-tube boiler; for instance, for heating street cars.

1,027,846. SYSTEM OF CONTROL FOR ELECTRIC MOTORS; A. J. Horton, White Plains, N. Y. App. filed Oct. 8, 1908. For a printing-press drive, etc.

1,027,857. TROLLEY; I. Kocian, Junction City, Kan. App. filed March 22, 1912. Grooved automatic replacing rollers.

1,027,895. ELECTRICALLY HEATED SADIRON; E. L. Pollard, Dobbs Ferry, N. Y. App. filed Nov. 22, 1910. Has removable heating units and a hinged cover.

1,027,898. FLECTRIC-CAR SWITCH; L. Radcliff, of Danvers, and E. E. Kilby, Mackinaw, Ill. App. filed June 23, 1910. Track and trolley switch.

1,027,970. HEATING APPARATUS; B. C. Allen, Chicago, Ill. App. filed Aug. 15, 1911. Liquid circulation.

1,028,033. APPARATUS FOR ELECTRICALLY CONTROLLING MACHINE TOOLS; C. Krämer, Frankfort-on-the-Main, Germany. App. filed Nov. 22, 1909. For planers, etc.

1,028,052. TROLLEY GUARD; H. H. McNeil, New Freedom, Pa. App. filed May 29, 1911. Yielding side vanes.

1,028,089. ELECTRIC SIGNALING APPARATUS AND CIRCUITS; F. B. Herzog (deceased), New York, N. Y. App. filed Nov. 6, 1893. Means for signaling from various floors of a building to two or more elevators and indicating which car is about to stop. (Ninety-seven claims.)

1,028,092. FIXTURE FOR VACUUM-TUBE LAMPS; D. McF. Moore, Newark, N. J. App. filed Feb. 26, 1907. The tube is supported by the conduit.